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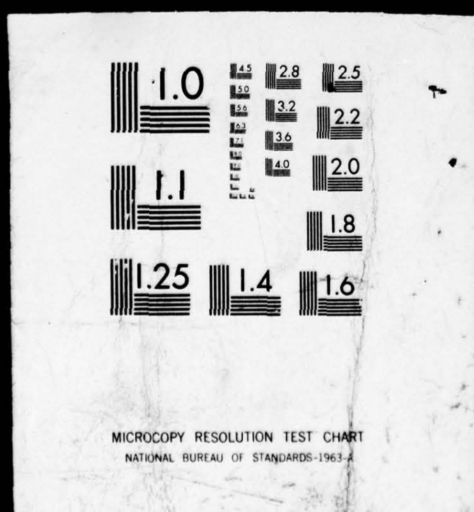

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S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM.

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FOREWORD

This report was prepared by the Vought Systems Division of LTV Aerospace Corporation, Dallas, Texas under the terms of contract N62269-73-C-0610. It is the final technical report and covers all work completed under this contract. The program is sponsored by the Air Vehicle Technology Department, Naval Air Development Center (NADC), Warminster, Pennsylvania, 18974. Mr. Anthony Manno, code 30331 is the Project Engineer for NADC.

The following Vought personnel were the principal contributors to the program: O. E. Dhonau, Project Engineer; E. G. Blosser, Advanced Manufacturing Technology; J. E. Littlefield, Structural Design; J. E. Madorin, Product Design; J. F. Bradshaw, Value Engineering; B. W. Staff, Quality Assurance; R. J. Calvert, Engineering Test Lab; and R. S. Rembert, Engineering Materials.

This report was prepared under Vought Systems Division Report Number 2-53443/4R-3172.

SUMMARY

The S-3A spoiler is designed as a cost competitive lightweight replacement for the metal spoiler, and is fit and functionally interchangeable with the existing part. The spoiler is of sandwich construction with graphite/epoxy faces and non-metallic core. The component was assembled by co-curing the wet laminate faces and HRP core.

Structural analysis and design of the composite spoiler was based on existing criteria and load requirements as specified for production components. Design verification and manufacturing development tests were conducted to predict structural capability and solve manufacturing problems encountered during fabrication. The component is deflection critical and sizing was based on this consideration.

Five components were fabricated. The manufacturing development article was cut into element specimens and tested to evaluate manufacturing processes. Three components were static tested, and successfully met design requirements. One component was successfully fatigue tested to four lifetimes without failure of any composite parts.

A cost monitoring system was employed throughout the span of the program and each cost element was identified. A cost matrix and graph comparing the metal and composite components was constructed. Cost data for the composite was extrapolated to 200 units and compared to actual and projected metal cost.

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LIST OF REFERENCES

REFERENCE NUMBER		REPORT NO.
1	CONTROL SYSTEM AND CONTROL SURFACE LOADS (S-3A)	LR 24691
2	S-3A WING CONTROL SURFACES - INTERNAL LOADS AND STRESS ANALYSIS.	LR 24597
3	S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM.	2-53443/3R-3139

SECTION 1
INTRODUCTION

The objective of this program was to develop a graphite/epoxy lower S-3A spoiler that is fully qualified to replace the existing metal component. The spoiler is both weight and cost competitive.

Five graphite epoxy spoilers were fabricated. One was sectioned to evaluate processes and manufacturing, three were static tested, and one was fatigue tested.

The program included material selection, verification testing, manufacturing and tooling development, structural analysis, and design effort necessary to develop a composite spoiler.

The S-3A spoilers are surfaces hinged off of the rear spar of the wing. They function as roll control devices and speedbrakes. Each wing has four spoilers, three upper and one lower. The lower spoiler is located on the wing underside, and is a simple beam supported by two hinge fittings. The spoiler is positioned by a push rod attached to each fitting. Its planform is quadrilateral approximately 85" long, 8" wide at the outboard end and 15" wide at the inboard end.

A composite spoiler assembly, composed of only four (4) basic parts was designed as a direct replacement for the existing lower metal spoiler assembly. A series of tests were defined and conducted for design verification. Four types of manufacturing development subcomponents were fabricated to check on details of component producibility. Then a complete component was produced to check out the tooling and manufacturing processes. Finally, four test articles were produced for static and fatigue testing. The complete assembly, including the trailing edge seal, is shown in Figure 1.

The four completed test spoilers were shipped to Naval Air Development Center for testing. The three static tests to failure were satisfactorily concluded and the fatigue tests were run successfully exceeding design requirements. Test reports from the NADC are included in Appendix B.

During the program a cost monitoring system was employed to monitor each cost element. The system consisted of an alpha-numeric code by which each cost

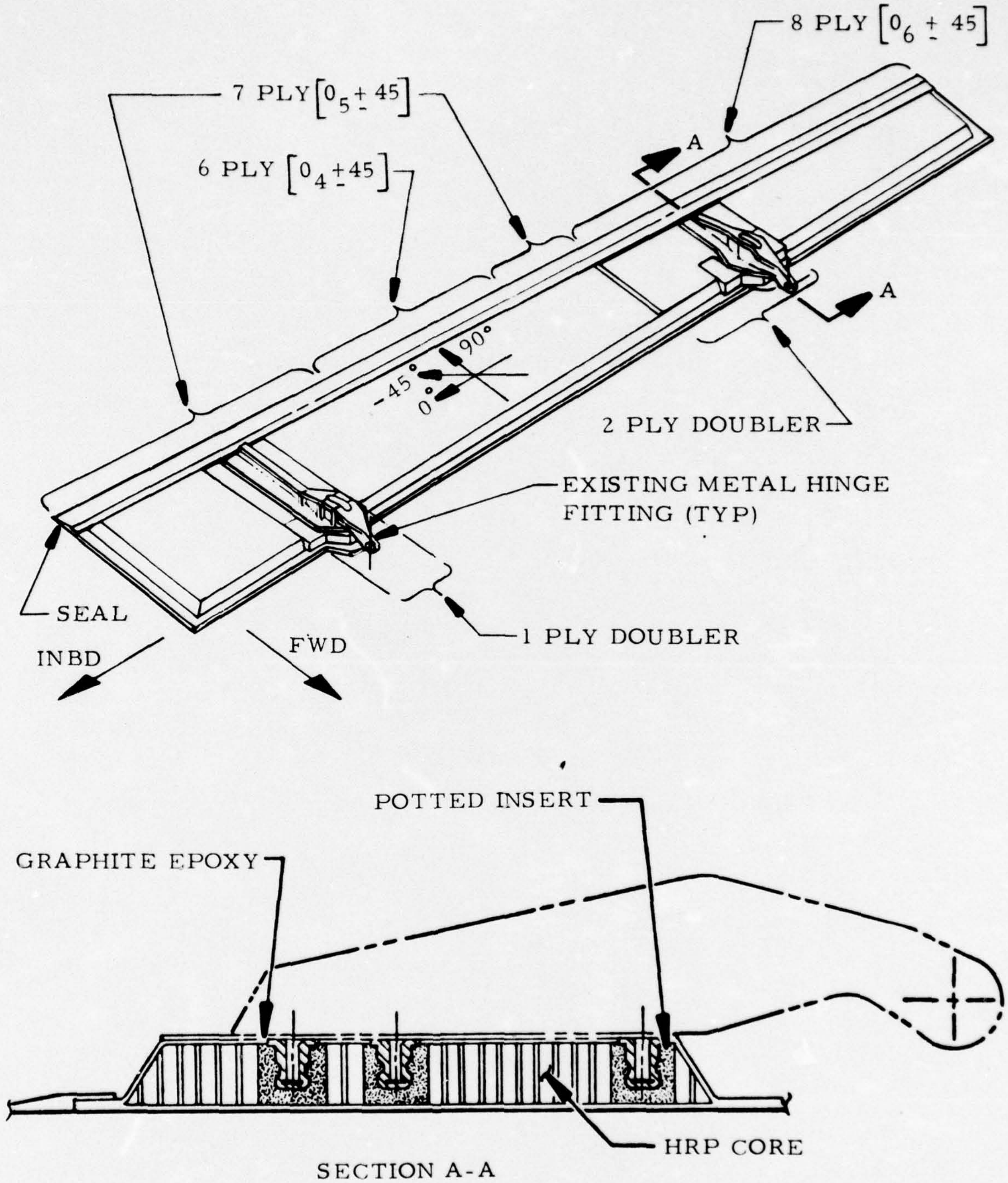


FIGURE 1 COMPOSITE SPOILER ASSEMBLY

element was identified. As costs were incurred on each component they were recorded and compiled, then extrapolated to 200 units for comparison with the costs of metal spoilers.

SECTION 2

ENGINEERING DESIGN AND ANALYSIS

COMPONENT DESCRIPTION

The composite spoiler is a direct replacement for the lower metal spoiler. It fits in the same space, is hinged off the existing outer panel rear spar supports, and utilizes the same actuation system. The general dimensions are shown in Figure 2. The spoiler is composed of two contoured graphite/epoxy skins of variable thickness, a glass reinforced plastic honeycomb core, and two existing metal hinge fittings attached with fourteen (14) bolts threaded into inserts potted in the core. The skin arrangement is shown in Figure 3. A new trailing edge seal design will be required for production utilization, but was not necessary for the test articles.

LOADS

Static Loads

The applied loads used to design the composite S-3A lower spoiler are the same as those used for the current metal design. These loads are derived from Lockheed Report LR 24691 (Ref. 1) and are shown in Figures 4, 5 and 6. Additional loads resulting from control system friction are accounted for by multiplying all closing hinge moments by a friction factor of 1.24. Axial loads resulting from support structure strain are eliminated from the design by incorporating free-play into the hinge design. Side loads applied to the spoiler hinges are a result of push rod positioning, spoiler slope and $\pm 3^\circ$ of assumed rod misalignment. All resulting side load is reacted at the outboard hinge.

Both the triangular and uniform distributions of airload are used in the design. The spoiler is critical for the triangular distribution and the hinges are critical for the uniform distribution.

Fatigue Loads

Fatigue loads, as defined in Reference 2, are shown in Table I. The spectrum represents 13,000 flight hours (one lifetime) with no scatter factor. One spoiler was fatigue tested to four lifetimes.

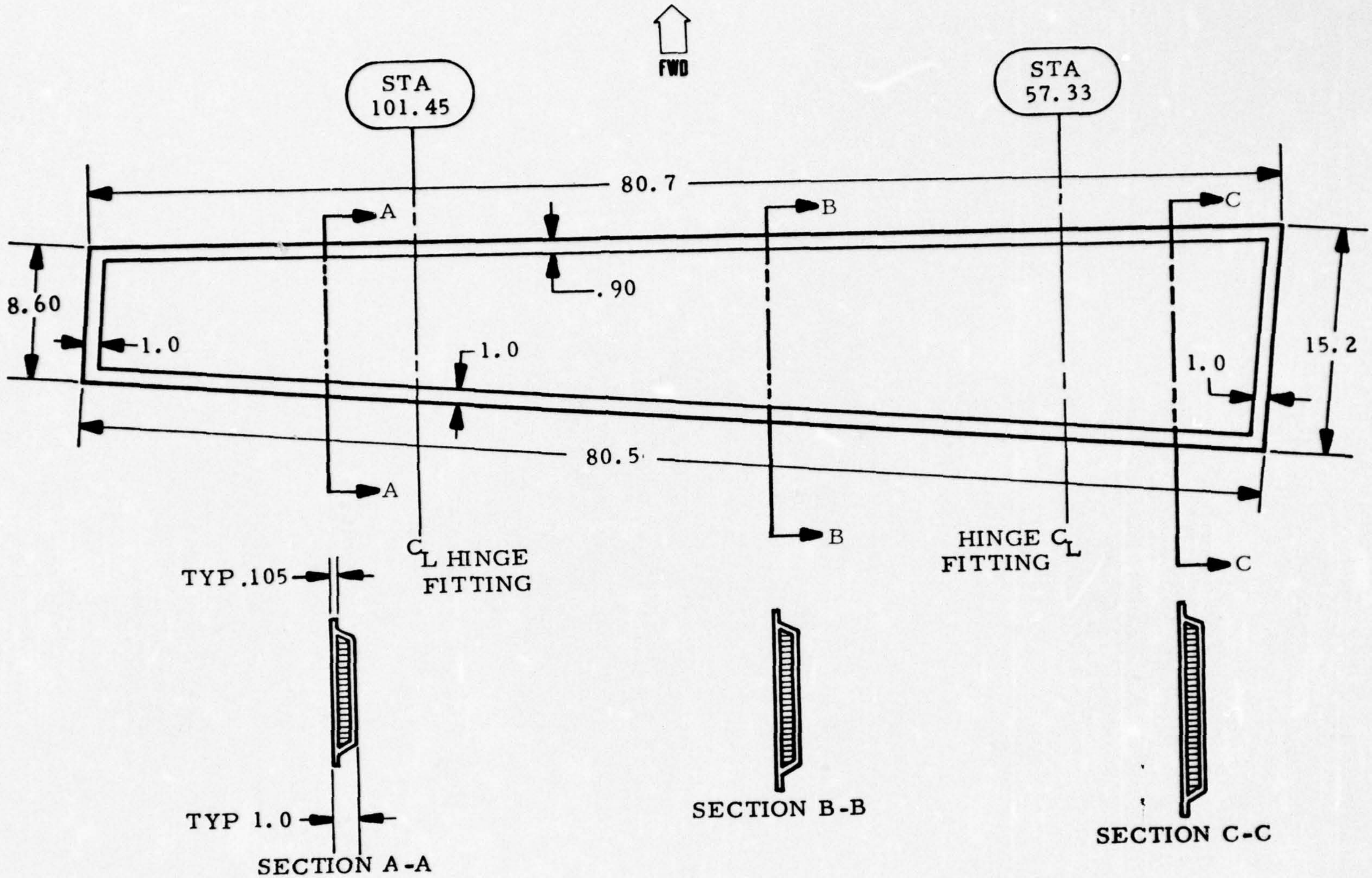


FIGURE 2 SPOILER GENERAL DIMENSIONS

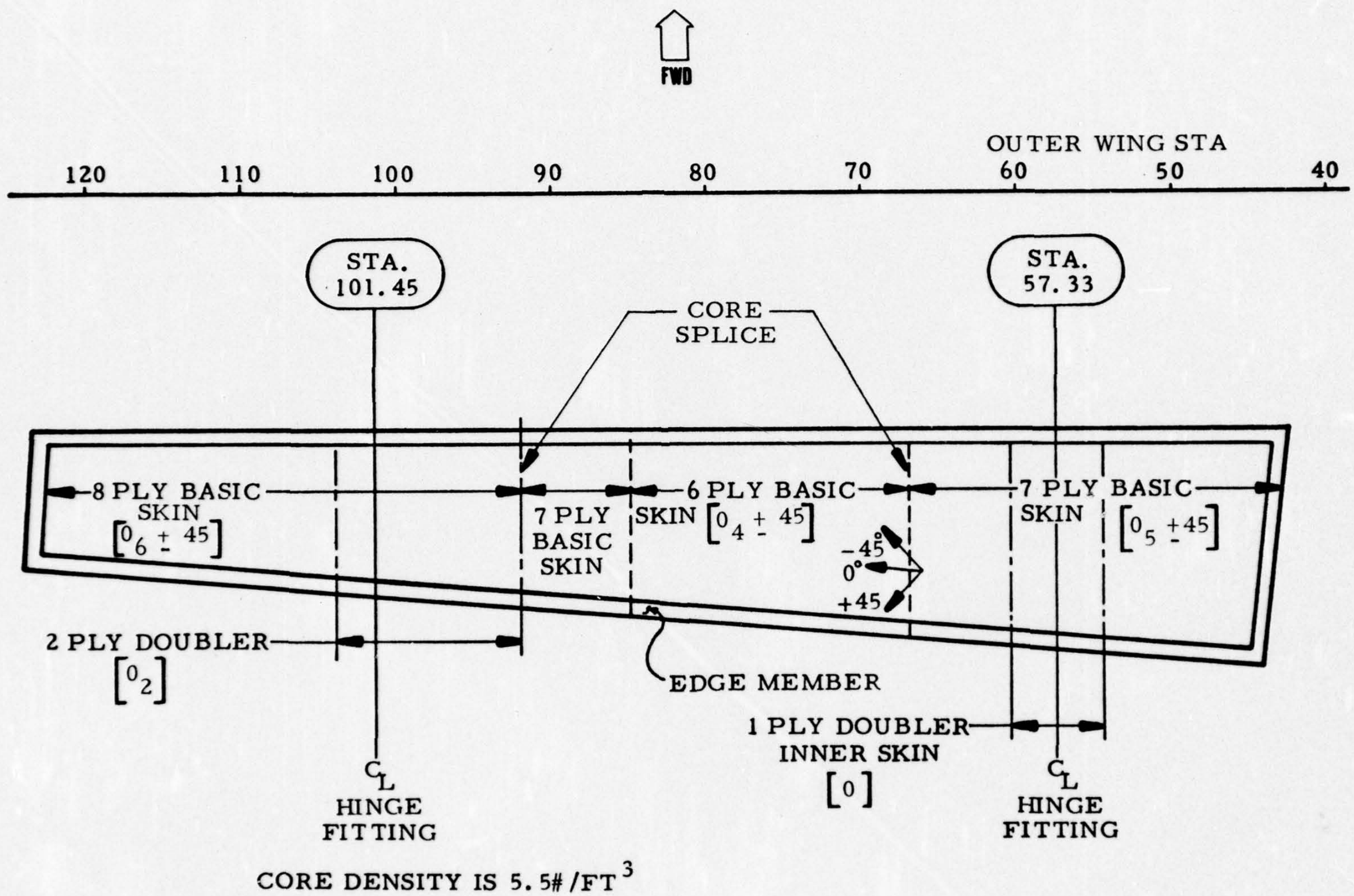


FIGURE 3 CORE AND SKIN ARRANGEMENT

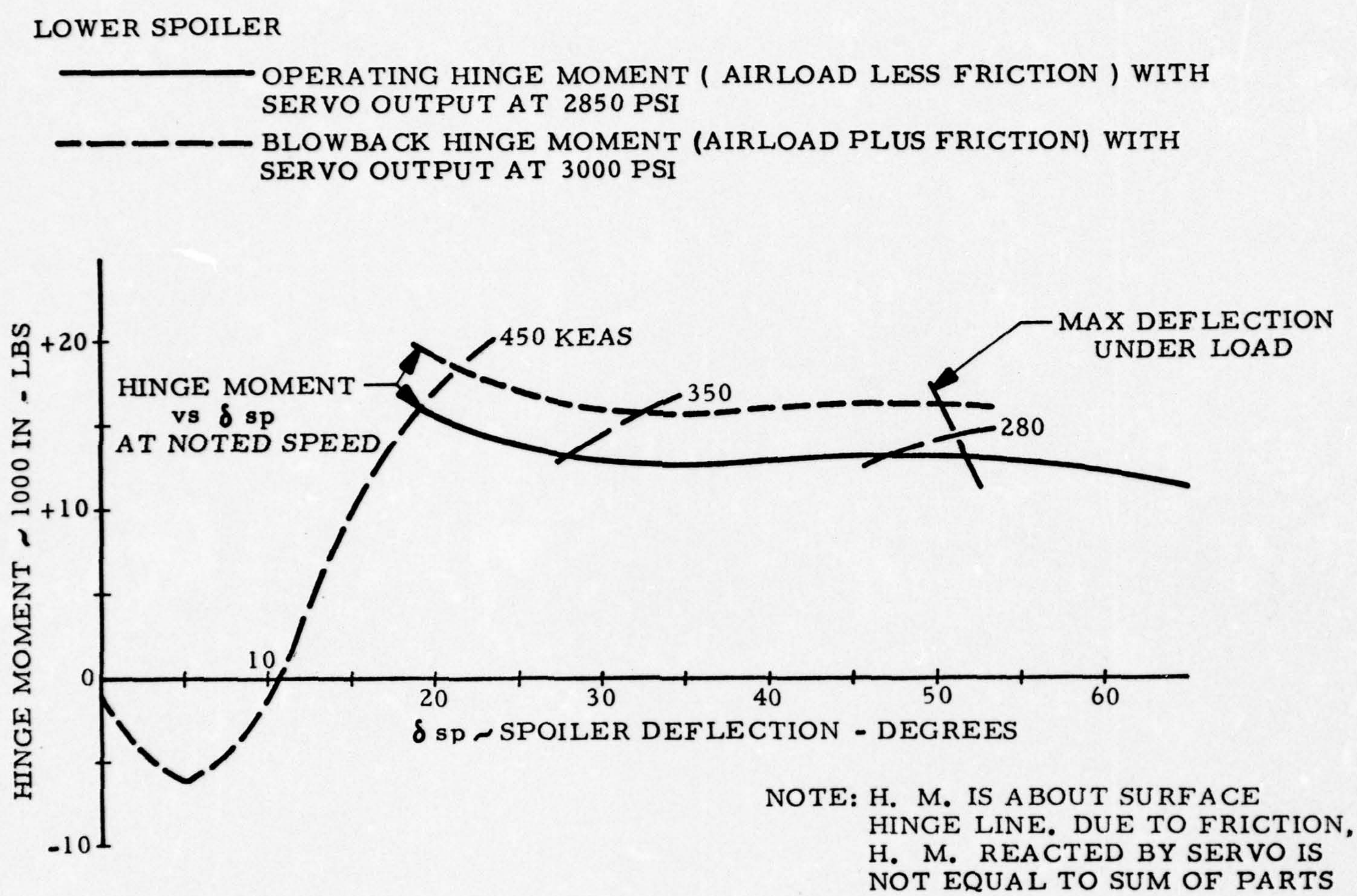


FIGURE 4 SPOILER HINGE MOMENTS

UNIT SPANWISE RUNNING LOAD

DISTRIBUTIONS FOR A TOTAL SURFACE HINGE MOMENT OF 1000 IN-LBS.

FOR CLOSING LOADS IN THE OPEN POSITION OR OPENING LOADS IN THE CLOSED POSITION.

<u>CHORDWISE DISTRIBUTIONS</u>

USE BOTH A UNIFORM AND A TRIANGULAR PRESSURE DISTRIBUTION PER SKETCHES BELOW FOR CLOSING LOADS. FOR FLAPS UP OPENING LOADS USE THE TRIANGULAR DISTRIBUTION. FOR FLAPS DOWN OPENING LOADS USE THE UNIFORM DISTRIBUTION

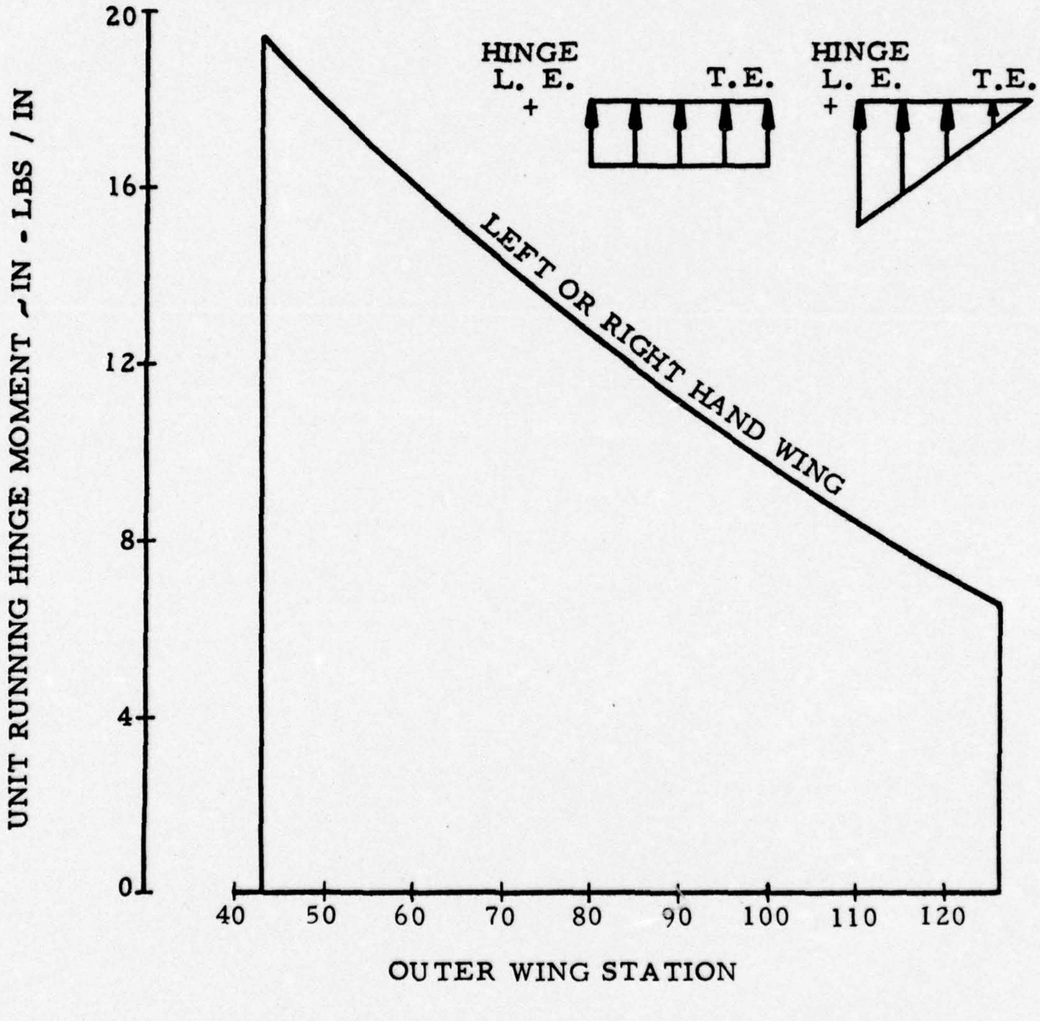
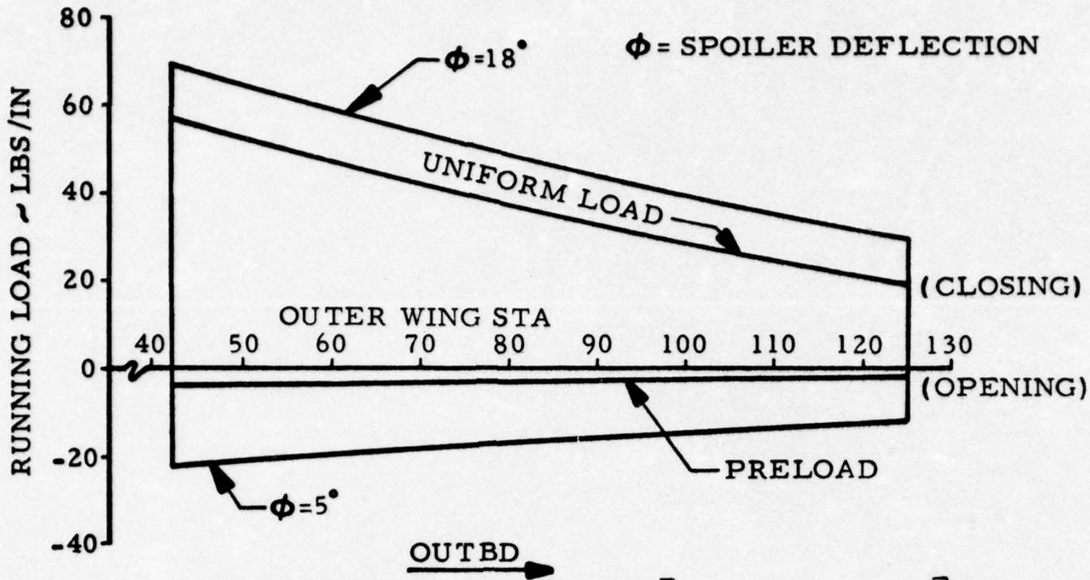
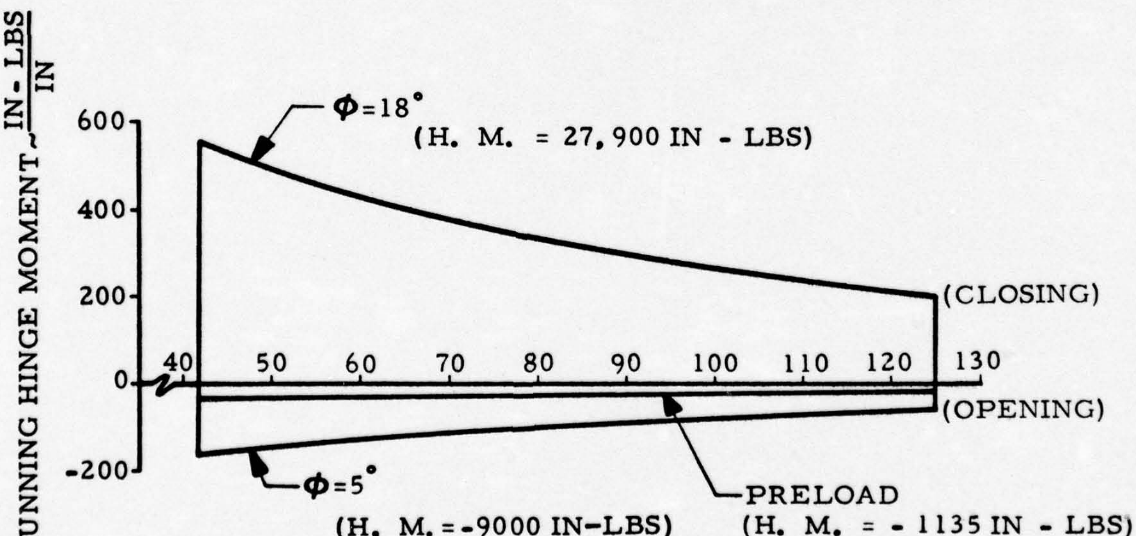


FIGURE 5 UNIT SPOILER LOAD DISTRIBUTIONS



LOWER SPOILER DESIGN LOADS [ULTIMATE LOAD]

NOTES: RUNNING LOADS DERIVED FROM TRIANGULAR PRESSURE DISTRIBUTION.
RATIO OF UNIFORM LOAD / TRIANGULAR LOAD=.76



LOWER SPOILER HINGE MOMENTS (ULTIMATE)

FIGURE 6 DESIGN RUNNING LOADS

TABLE I FATIGUE LOADS

SPOILER SPECTRUM (REF. 2)

SURFACE	MIN H. M. (IN-LBS)	MAX H. M. (IN-LBS)	NO. OF OCCURRENCES/ 13,000 HRS
LOWER	-6,000 -7,080*	+12,000 +14,160*	20,000

* Includes increase in loads because of outboard upper spoiler deactivation

NOTES:

1) SIGN CONVENTION, POS. H. M. TENDS TO CLOSE SPOILERS
2) ONE OCCURRENCE IS: MIN H. M. TO MAX H. M. TO ZERO

MATERIALS SELECTION

Materials selected for spoiler fabrication are required to operate in a 180F environment. Co-curing at 260F during manufacture requires compatibility of the cure cycles of the graphite/epoxy, film adhesive and core splice material. Adhesive used for insert potting and the sealant used for honeycomb edge protection and faying surface protection require room temperature cures. The phenolic resin which stabilizes the beveled edges of the core requires a 350F oven cure.

Materials required for spoiler assembly include:

- G_R/E - Narmco 5209/T300
- Core - HRP - 5.5#/ft^3
- Adhesives
  - Film - M1113
  - Paste - EA 901
  - Foam - FM 37
- Sealant - ProSeal 890
- Phenolic Resin - SC 1008
- Threaded Insert - Shur-Lok SL 607

Evaluation and Qualification

Comparative data for Narmco 5209 and 5208 are shown in Tables II and III. This data was the basis for selection of the Narmco 5209/T300 graphite epoxy system. Advantages of the 5209 system are:

1. Modulus - the low viscosity 5209 resin system is suited to the well aligned T300 graphite fiber. With the better packing characteristics of the T300, higher fiber volumes are possible and consequently a higher

TABLE II QUALIFICATION DATA COMPARISON

PHYSICAL PROPERTIES OF UNCURED IMPREGNATED MATERIAL				
	NARMCO 5209/T300		NARMCO 5208/T300	
	TEST BATCH	REQUIRED (207-81-410/1)	TEST BATCH	REQUIRED (207-8-410/2)
Volatile Content, % wt.	.50	1.7 max	.90	1.7 max
Non-fiber Content, % wt.	43.8	41±4	42.6	41±4
Resin Flow, %	23	10-24 @250 F	20.2	10-24 @350 F
Gel Time	17	5-20 min @250 F	37	25-45 min @325 F
Tack	pass	30 min	pass	30 min
PHYSICAL PROPERTIES OF CURED LAMINATE				
Void Content	pass	NDT	pass	NDT
Density	1.53	1.56±.02	1.55	1.56±.02
Fiber Volume %	65.5	62.±4.	73.0	62.±4.

TABLE III PROCESS COMPARISON

	5209 (260 F Cure)	5208 (360 F Cure)
Cure temperature	260 F	350 F - 400 F
Cure Time, Hrs	1.5	4.0
Tooling	Aluminum or Fiber glass	Aluminum/Steel
Warpage	Lower Warpage	Higher Warpage
Adhesive Performance	High Peel and Strength	Low Peel and Strength
Co-curing	No over curing problem	Over curing problem

0° tensile and compressive modulus is available at comparable shear values. The 90° tensile and compressive modulus values are slightly lower.

2. Processability - cure temperature (260F) is lower than the 5208 system (350F). This causes less tool/part expansion problems, less heat up and cool down time, lower cost tooling materials and less tool fabrication costs.
3. Adhesive Compatibility - One of the advantages of using a 260F cure graphite/epoxy system is the concurrent capability of co-curing with a 260F cure adhesive as compared to a 350F cure adhesive. The M-1113 260F cure generates shear strengths of 5000-6000 psi and T-peel of 40-60 lbs/in. While tests at VSD demonstrate that 260F cure adhesives may be co-cured with 350F cure graphite epoxy laminates for 2-3 hours at temperature, it has been found that the shear strength of the 260F cure adhesive drops from the normal 5000-6000 range down to the 2000 to 3000 range. The best available adhesive system for spoiler usage is M-1113 with a 260F cure.
4. Cost - Since cost is a primary consideration, trade offs must consider cost of processing, see Table III. Lower cure temperatures lead to lower production costs, increased production rates with existing equipment, and decreased tooling costs. Almost double the production can be put through the same autoclave with a 1.5 hr. cure cycle as can be put through at 4 hours with a 360F cure material.

Core Material

The selection of the core was governed largely by the requirement to minimize the use of metals in conjunction with the graphite/epoxy materials. This avoids the problem of galvanic reactions and corrosion which are common to aircraft components in naval environments. The core used is Hexcel HRP glass core which is compatible with the materials and process requirements of the graphite/epoxy being used. A constant core density of 5.5#/ft^3 is used to reduce the required number of splices from five to three splices per assembly.

Specifications

All specifications used on this program are listed in Table IV.

Material Allowables

Unidirectional lamina strength and elastic properties for NARMCO 5209/T300 intermediate strength graphite/epoxy are shown in Table V. These data were the basis of initial component design.

TABLE IV MATERIALS AND PROCESS SPECIFICATIONS

TYPE SPECIFICATION	VSD SPECIFICATION NUMBER	TITLE
Process	208-8-3	Graphite Tape and Sheet, Resin Impregnated for Hand Layup
Material	207-8-410/1	Graphite Fiber Tape and Sheet. Epoxy Resin Impregnated
Material	207-8-415	Film Adhesive and Primer for Bonding Precured Composite Laminate and Sandwich Structures
General	207-8-410	Graphite Fiber Tape and Sheet. Epoxy Resin Impregnated
Material	207-8-417	Core Filling Compound, Two Part Paste
Material	207-8-408	Adhesive System for Bonding of Aluminum-to-Aluminum and Alumi-Faces to Non-Perforated, Aluminum Honeycomb Core for 180°F Service (Type III only)
Process	CVA8-51	Aluminum, Cleaning and Etching for Bonding
Material	207-8-411	Core, Honeycomb non-metallic
Material	CVA8-405	Epoxy Adhesives
Process	CVA8-206	Bonding with Epoxy Adhesives
Material	CVA-6-579	Heat Resistant Sealant, 250°F Service Temperature
Process	CVA6-177	Sealing Compounds Preparation and Application of
Process	CVA8-39	Metalite, Fabrilite, and Wood Parts, Protection of
Process	208-8-12	Bonding of Metal-to-Metal and Metal Faces to Honeycomb Core for 180° Service
Process	208-7-18	Epoxy Reinforced Solid Laminates and Laminate Facings for Sandwich Construction, Fabrication of

TABLE V UNIDIRECTIONAL PROPERTIES OF 5209/T300 GRAPHITE EPOXY

PROPERTY		TENSION	COMPRESSION	SHEAR
MODULUS OF ELASTICITY (LBS/IN²)	E_1	19.0×10^6	19.0×10^6	—
	E_2	1.5×10^6	1.5×10^6	—
	G_{12}	—	—	0.7×10^6
ULTIMATE STRENGTH (LBS/IN²)	F_1	170,000	170,000	10,000
	F_2	8,000	25,000	10,000
STRAIN LIMIT (IN/IN)	e_1	0.00895	0.00895	—
	e_2	0.00532	0.01660	—
	γ_{12}	—	—	0.01420
DENSITY ρ (#/IN³)			0.058	
POISSON' RATIO μ			0.210	
INTERLAMINAR SHEAR STRESS F_{isu} (#/IN²)			13,000	
COEFFICIENT OF EXPANSION (MICRO-IN/IN/°F)	α_1		0.3×10^6	
	α_2		14.4×10^6	

PROPERTIES FROM TABLE V WERE USED IN CONJUNCTION WITH POINT STRESS COMPUTER ROUTINES TO DEVELOP THE GENERAL MATERIAL PROPERTIES

Values are shown as B-basis allowables where a sufficient data base is available. The B-basis allowables are defined as the value above which at least 90 percent of the population of values are expected to fall, with a confidence of 95 percent.

Design allowables for other non-metallic materials including core and adhesives are presented in Table VI. Strength data are from sources such as industry specifications, military specifications, R&D programs, and prior in-house testing.

For final design and structural analysis of the critical sections, allowables were modified where verification or qualification tests indicated this information did not apply.

ANALYSIS

Structural Analysis

Stress analysis of the composite spoiler is presented in this section. The analysis covers the critical areas of the plank, and includes analysis of the graphite/epoxy faces, the HRP honeycomb core, and the potted inserts used to attach the hinge fittings. The critical loading conditions, shown in Figures 4 through 6, were used for the analysis. The spoiler surface is critical for the triangular airload distribution.

Shear, moment and torsion diagrams for the simply supported spoiler surface, are shown in Figure 7. The laminate bending and torsional stress shown in Figure 8 was calculated using beam theory and hand methods of analysis. Margins-of-safety for the critical sections were calculated using a computer analysis program. The program is a point stress analysis of a laminated orthotropic structure subject to in-plane loads.

Deflection

The spoiler cavity is restricted in depth and little cross section is available to provide the required structural stiffness. Stiffness is critical because an excessive amount of deflection would result in unacceptable gaps when the spoiler is in the open position.

Figure 9 is a comparison of the calculated graphite and metal spoiler stiffness. Outboard of hinge Station 101.45 the graphite spoiler is stiffer. The increase helps reduce the critical tip deflection at the outboard end of the spoiler.

TABLE VI - MATERIALS ALLOWABLES

	COMPRESSIVE		SHEAR			
			L. DIR.		W. DIR.	
HEXCELL HONEYCOMB CORE	STRENGTH	MODULUS	STRENGTH	MODULUS	STRENGTH	MODULUS
HRP 3/16 - 4.0 #/FT ^{3}	Psi	Ksi	Psi	Ksi	Psi	Ksi
VENDOR DATA	370	57	212	11.5	110	5.0
(VSD 207-8-411)	(370)		(180)*	(10.0)	(94)*	(5.0)
HRP 3/16 - 5.5 #/FT ^{3} VENDOR DATA	600	95	350	19.5	190	8.5
(VSD 207-8-411)	(600)		(293)*	12.6	(150)*	(6.8)

		VENDOR DATA	TEST DATA
INSERTS SL607	TENSION -	900 LBS.	1210 LBS.
	SHEAR -	905 LBS.	N/A
	TORSION -	150 IN/LBS.	280 LBS.

FILM ADHESIVE (M1113)	-67°	4500 PSI
MIN AVE SHEAR STRENGTH	75°F	4500 PSI
PER VSD 207-8-415	+ 180°F	3400 PSI
CORE SPLICE ADHESIVE (FOAM) FM 37 CORE SHEAR STRENGTH PER VSD 207-8-408, (TYPE III)		650 PSI
INSERT POTTING ADHESIVE (EA 901) SHEAR STRENGTH PER VSD 207-8-405, (TYPE VI)	@ 75°F	2500 Psi

* Adjusted for core depth

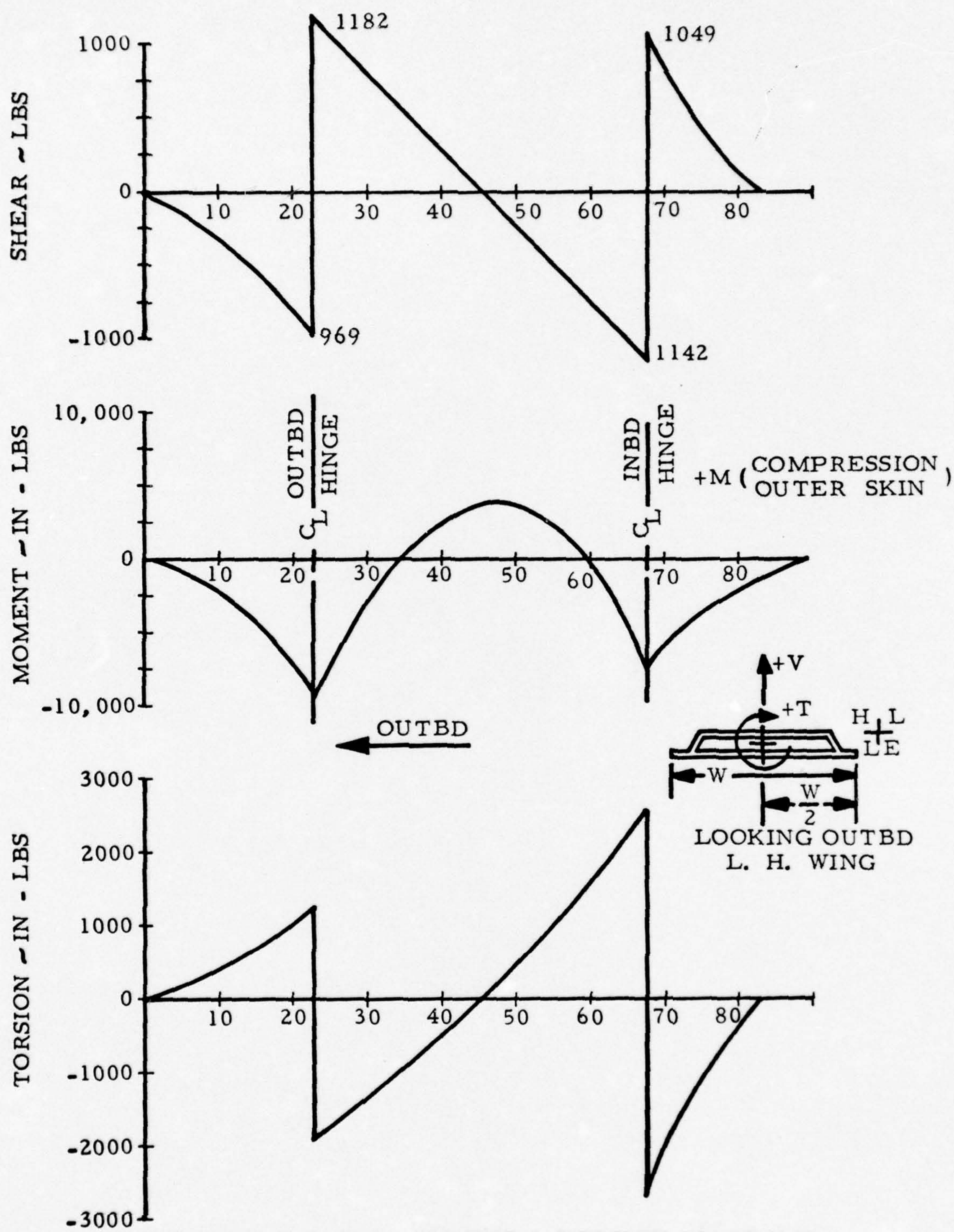


FIGURE 7 SHEAR MOMENT & TORSION DIAGRAMS

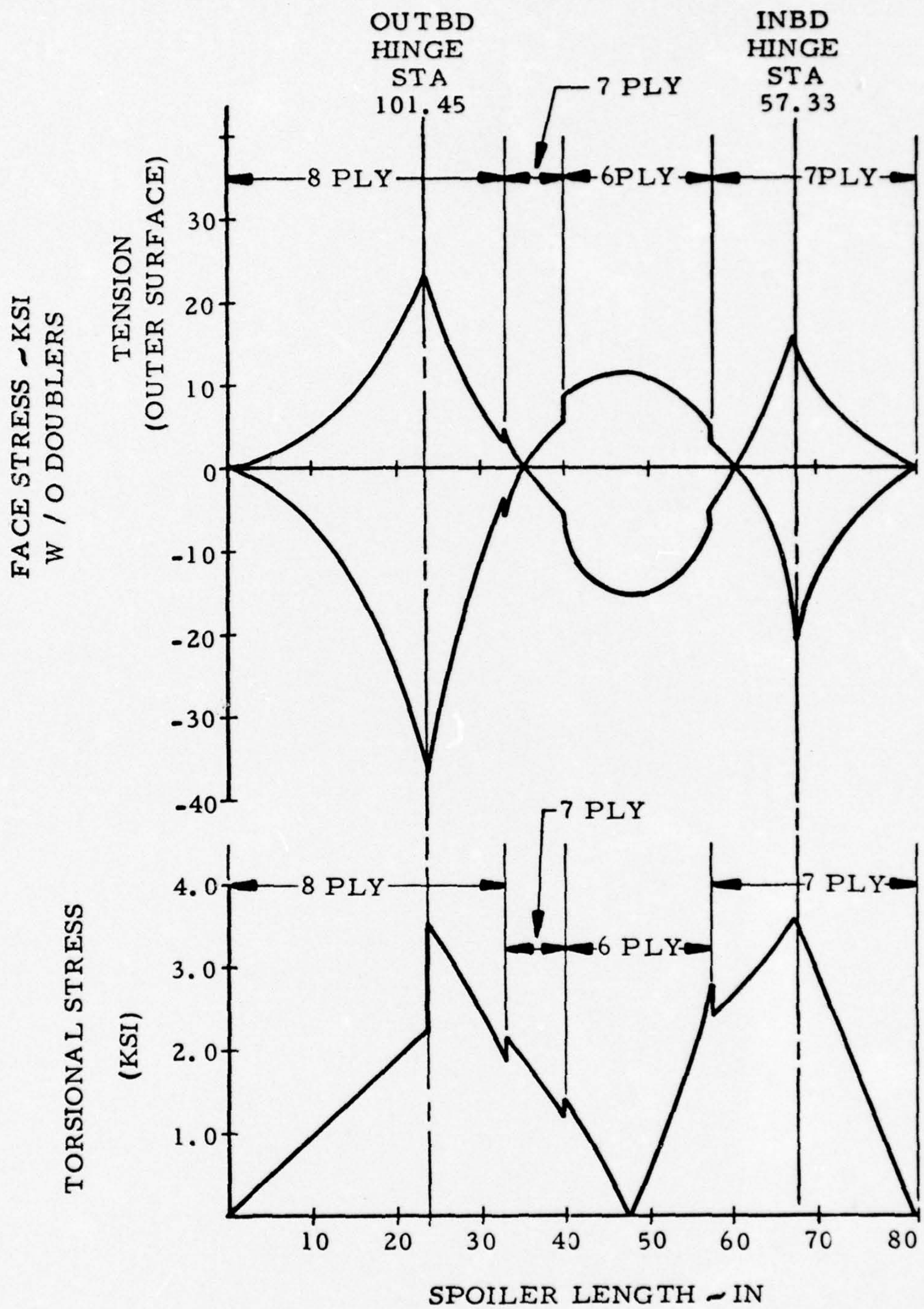


FIGURE 8 SKIN STRESS

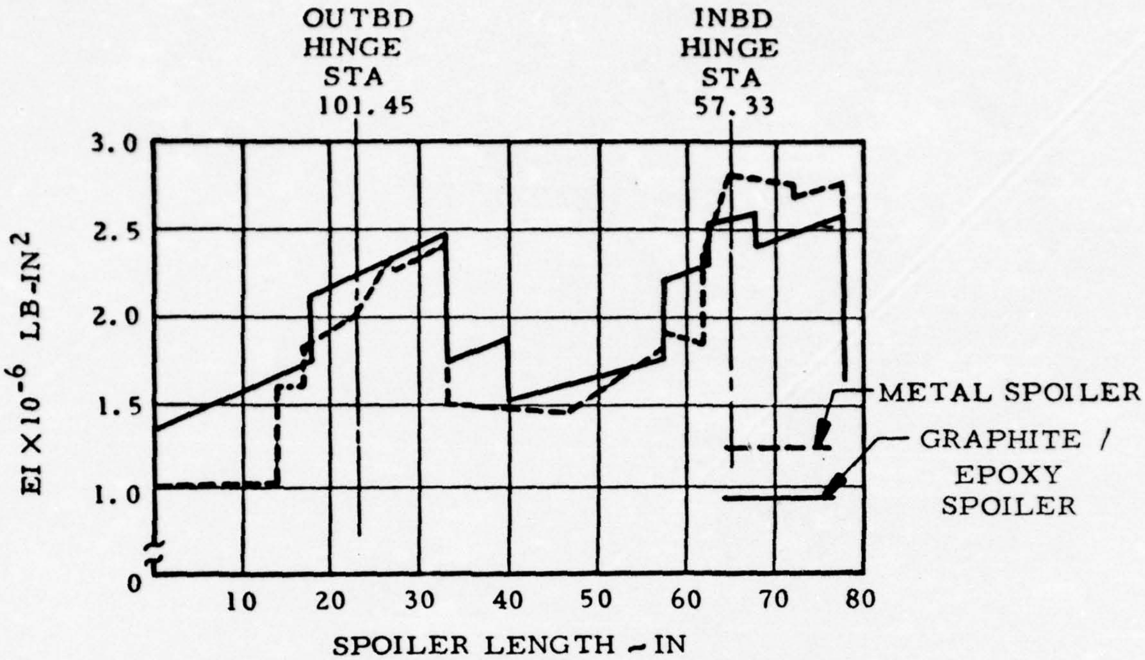


FIGURE 9 SPOILER STIFFNESS COMPARISON

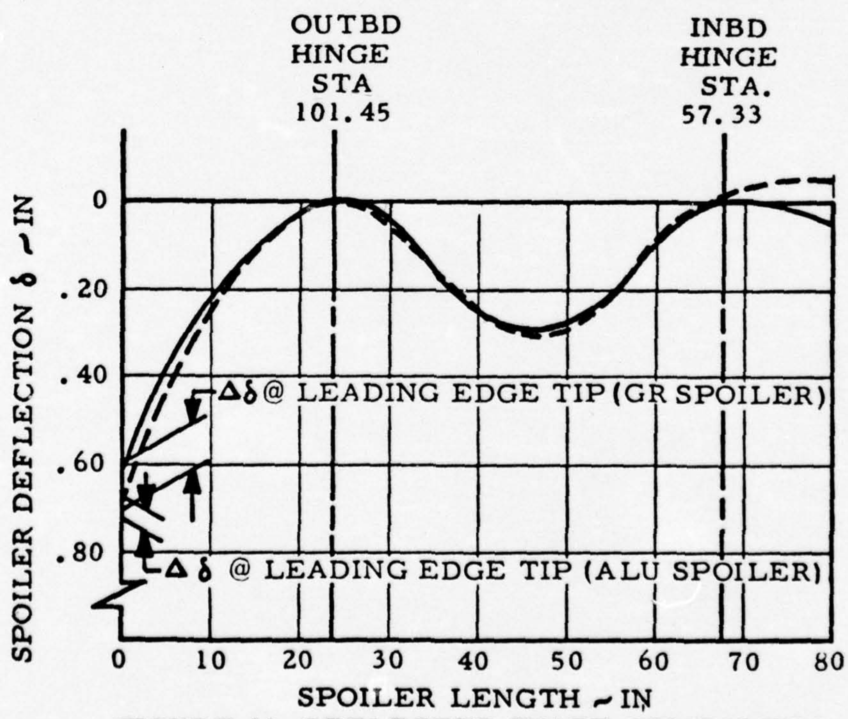


FIGURE 10 DEFLECTED SHAPE COMPARISON

A comparison of the calculated deflected shape of the aluminum and the graphite spoilers is shown in Figure 10. The modulus of elasticity used to calculate the spoiler section properties was reduced by 17.5 percent as a result of design verification tests (see TR 150 discussion). The reduction was based on the minimum value obtained in the test. The values are considered conservative and actual measured deflections were slightly lower.

Analysis of Laminate

Two checks at the critical point, outer hinge Station 101.45 were made. The first check considered the basic cross section without the local effect of the insert cutouts and added local doublers. The stress levels are those shown in Figure 8. This stress is converted to running load for input into the laminated structural analysis routine as follows:

Compression inner surface

$$N_x = f_c\ t = (36{,}800)\ (0.040) = 1472 \text{ lb/in.}$$

Tension outer surface

$$N_x = f_t\ t = (22{,}425)\ (0.040) = 897 \text{ lb/in.}$$

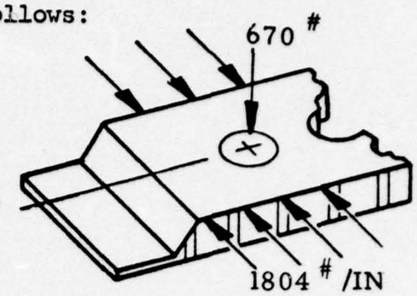
Torsion

$$N_{xy} = (3550)\ (0.040) = 142 \text{ lb/in.}$$

The combined loading effect, results in a minimum margin-of-safety of .97 for the inner skin and 1.05 margin-of-safety for the outer surface. The margin-of-safety calculations were based on a limiting strain of .007 compared to the design value from Table V of .00895. The reduced value was used based on the results of design verification tests as discussed under TR 141 data.

The second analysis at Station 101.45, where the highest bending stress occurs, considers laminate cutout and added doubler ply effects. As shown below, the same running load is applied as in the previous analysis except an additional load is added. This accounts for the effect of the out-of-plane load applied at the insert. The relationship between the out-of-plane "P" load to the in-plane load is based on strain gage information derived from the design verification tests summarized in TR 135 discussion. The calculated margins of safety using the VSD program was based on a limiting strain acquired from design verification test TR 141. The beam test results show

that limiting strain, which includes the loss of strength for the cutout, to be .0055. The detail analysis is as follows:



Running Load (Compressive Bending)

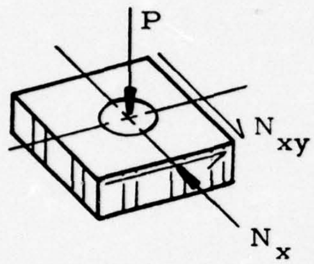
N_x = 1472 lb/in. ULT

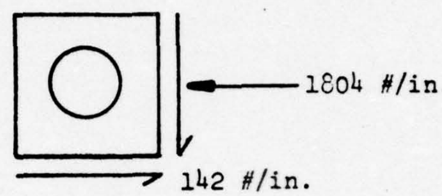
Running Load (out-of-plane insert load)

N'_x = 332 lb/in ULT

Total $N_{x_T} = N_x + N'_x = 1472 + 332 = 1804$ lb/in ULT

Element





Margin of Safety

(Allowable Strain Based on Test) M. S. = .76

Core Analysis

Figure 11 is a plot of core applied shear versus allowable shear based on minimum specification requirement of Table V. The peak stress shown is based on an effective width of 4.50 inches in the area of the inserts.

Insert Analysis

The spoiler plank is supported by two hinge fittings located at Station 101.45 and Station 57.33. The fittings which transmit spoiler loads to the support structure are mounted to the spoiler plank through fasteners bolted into inserts which are potted into the honeycomb core. The principle loads on the inserts are compression. Loads are conservatively considered to be reacted entirely by the inserts and are transmitted into the honeycomb core through

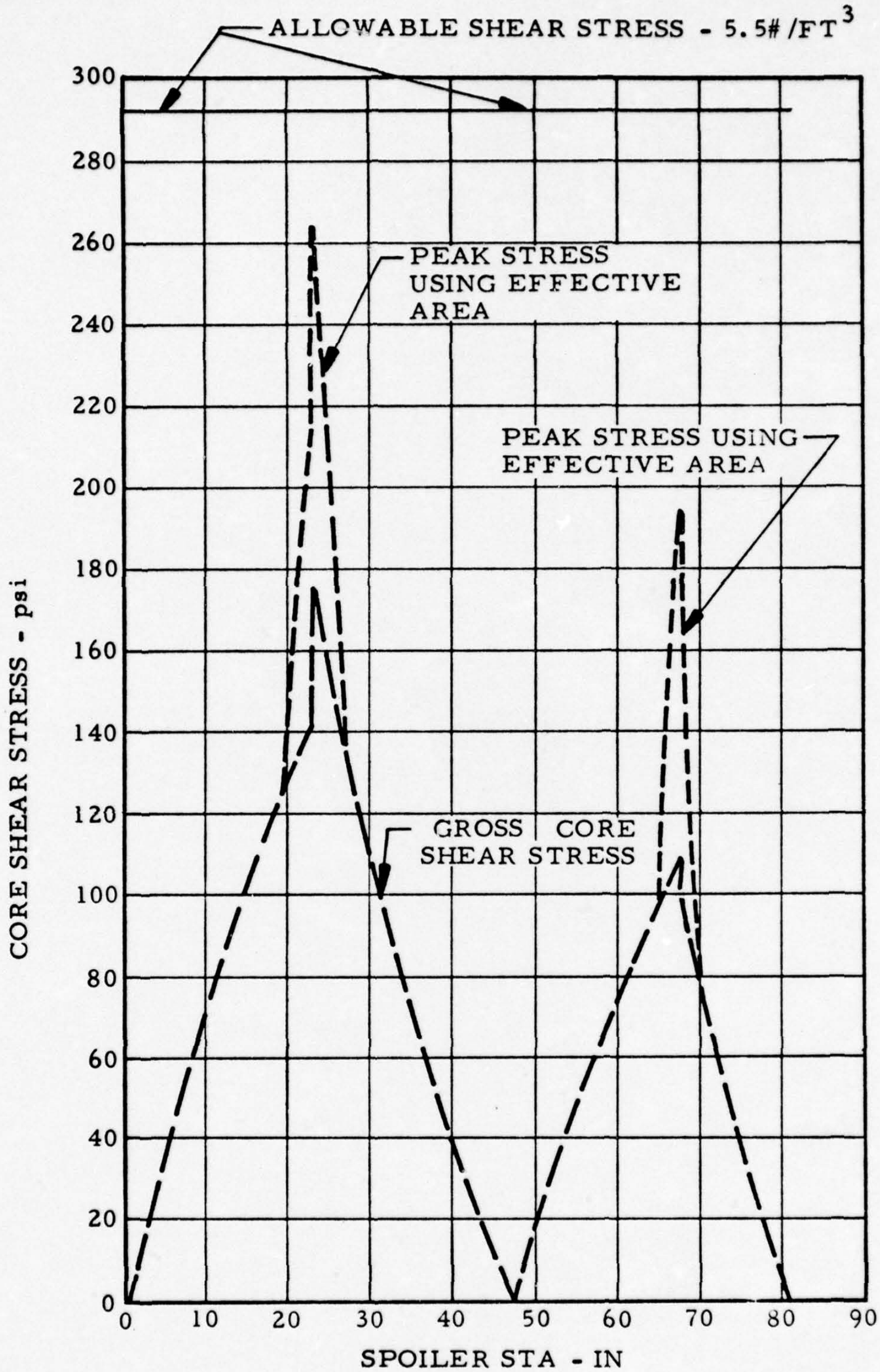
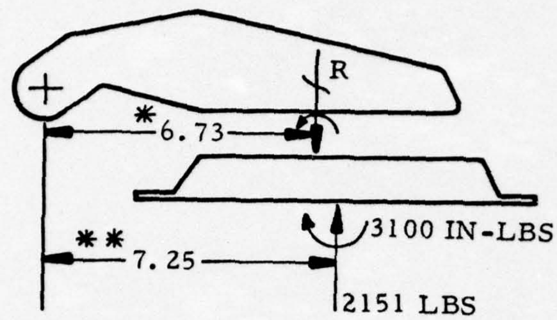


FIGURE 11 CORE SHEAR STRESS

the potting (see page 24 for analysis). The margin-of-safety calculation is based on a load allowable taken from test results; the allowable is the minimum value obtained from the test data.

The spoiler to hinge fastener load distribution calculation at the outboard hinge (triangular airload distribution) is shown below:



* Distance from C_L hinge to bolt pattern centroid

** Distance from C_L hinge to center of cross section

The maximum bolt load has 3 components as follows:

P_1 from normal loads

P_2 from moments chordwise

P_3 from moments from side load

$$P_1 = \frac{2151}{6} = 358 \text{ lbs/fastener}$$

$$P_2 = \frac{M\rho}{\Sigma\rho^2} = \frac{[3100 - 2151\,(7.25 - 6.73)]\;2.57}{10.66} = 478 \text{ lbs}$$

This load is distributed over 2 fasteners

P_2 = 239 lbs/fastener

$P_3 = \frac{M}{h}$ side

Where M = 260 lbs x 1.26" = 328 in-lbs

h = 1.50 in effective at 3 location = 4.5 in

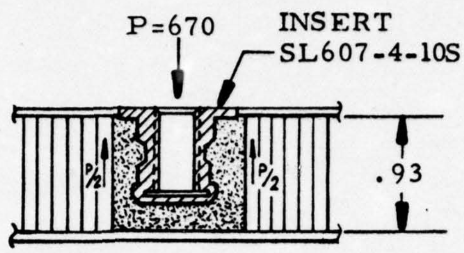
$$P_3 = \frac{328}{4.5} = 73 \text{ lbs/fastener}$$

Total fastener load is:

$$P \text{ compression} = P_1+P_2+P_3 = 670 \text{ lbs}$$

$$P \text{ tension} = P_1-P_2+P_3 = 192 \text{ lbs}$$

A check for local core shear stress adjacent to the insert is made as shown.



Allowable Stress based on test P = 1210#

$$\text{M. S.} = \frac{1210}{670} - 1 \qquad .80$$

DESIGN VERIFICATION TESTS

A series of subcomponent tests verified the spoiler design.

Table VII lists the subcomponent tests performed for this program.

TABLE VII - DESIGN VERIFICATION TESTS

TR NUMBER	SUBJECT
TR-135	STRENGTH EVALUATION OF POTTED INSERTS
TR-140	TENSION, COMPRESSION AND SHEAR PROPERTIES OF HRP CORE/GRAPHITE FACED SANDWICH STRUCTURE
TR-141	SANDWICH BEAM FLEXURE TESTS
TR-142	HINGE FITTING/SANDWICH PANEL TESTS
TR-147	PANEL EDGE CLOSE OUT TEST
TR-150	COMPRESSION PROPERTIES - CO-CURED SANDWICH SPECIMENS

TR-135 Strength Evaluation of Potted Inserts

Tension and compression strengths of potted inserts were tested in 4.00 inch rectangular specimens. Torsional strengths were tested in 2.00 inch rectangular specimens. All specimens were fabricated with a 5.5 $\#/ft^3$ HRP core and 7 ply graphite/epoxy faces. The inserts were potted in the same manner as in the spoiler assembly in both fixed and self-aligning versions. Table VIII summarizes the test data. The tension and compression test fixture is shown in Figure 12.

TR-140 Tension, Compression and Shear Properties of HRP Core/Graphite Faced Sandwich Structure

Flatwise tension and compression and short beam shear tests were run to determine the properties of a basic sandwich construction using HRP core and graphite/epoxy faces. The test results are summarized in Table IX. The test fixture for the core shear test is shown in Figure 13.

TR-141 Sandwich Beam Flexure Tests

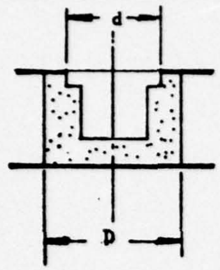
The flexural strength of the spoiler at the inboard and outboard hinge locations was verified with and without inserts. Two series of tests were conducted with a four point loading system as shown in Figure 14.

Specimens IWO, OWO, OW and IW were initially tested to evaluate basic ply strength and component capability in the inboard and outboard hinge area. All specimens failed in the area of maximum moment (on the compression face) except two specimens that failed outside the test area. Specimens failed at lower longitudinal strains than predicted using allowables of Table V. Loss of capability was attributed to local dimpling between cells when the laminate was co-cured to the core.

To determine the effect of dimpling on tensile strength, eight tension specimens (IWO1-1 thru -4 and IWO2-1 thru -4) were cut from the laminate skins of flex beam specimens IWO1 and IWO2. As shown in Table X, no significant strength or modulus loss was noted.

After an additional ply of material was added to the basic component skin to compensate for the loss of stiffness from dimpling, fifteen (15) additional specimens (BIW, BOW, and BOWO) were fabricated and tested to evaluate the full scale component capability. Three of the specimens (BOWO-1 thru -3)

TABLE VIII TR-135 STRENGTH EVALUATION OF POTTED INSERTS

TENSION/COMPRESSION	FASTENER TYPE	FINAL DIMENSIONS	FACE SHEET	CORE TYPE	SPECIMEN NO.	FAILING LOAD	DESIGN LOADS	DESCRIPTION OF FAILURE
	Self-align	d=.749-.755	7 ply 5209 -T300	HRP 3/16 cell 5.5 #/ft^3	1	1315 lb	670#	COMPRESSION
		D=.999-1.005			2	1325		
					3	1180		
					1	1255		
					2	1525		
					3	1575		
	Fixed	d=.499-.504			1	1180		
		D-.749-.754			2	1455		
					3	1425		
					1	1450		
FAB PROCEDURES					2	1350		
#1 UPPER CO-CURED LOWER PRE-CURED					3	1210		
	self-align	d=.687-.693			1	500		
		D=.937-.943			2	450	670#	COMPRESSION
#2 UPPER CO-CURED LOWER CO-CURED					3	1465	192#	TENSION
	Fixed	d=.562-.567			1	1330	670#	COMPRESSION
		D=.812-.817			2	1115	670#	COMPRESSION
					3	1320	192#	TENSION
TORSION	Self-align	d=.749-.755			1	260 IN-LB	70 IN-LBS	TORSION
		D=.999-1.005			2	220		
					3	240		
	Fixed	d=.499-.509			1	340		
		D=.749-.754			2	320		
					3	280		
	Self align	d=.687-.693			1	180		
		D=.937-.943			2	200		
	Fixed	d=.562-.567	7 ply 5209 -T300	HRP 3/16 Cell 5.5#/ft^3	1	200		
		D=.812-.817			2	260	70 IN-LBS	TORSION

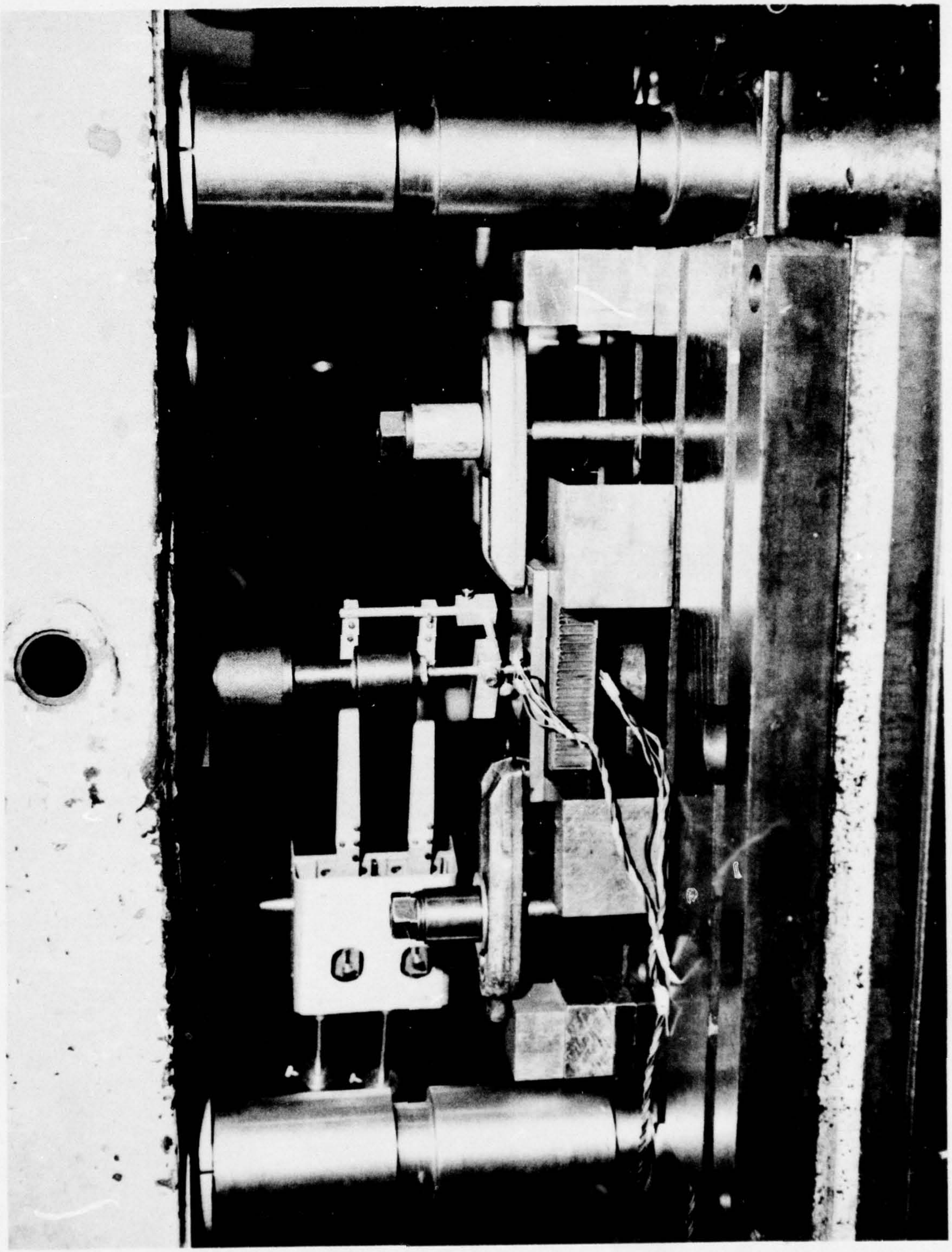


FIGURE 12 INSERT SPECIMEN TEST FIXTURE (TR-135)

TABLE IX TR-140 VERIFICATION TEST OF SANDWICH CORE/GRAPHITE LAMINATE

SPECIMEN NO.	FACE SHEET	CORE TYPE	FAB PROCEDURE	FAILING LOAD (LB)	FAILING STRESS (PSI)	DESIGN STRESS (PSI)	DESCRIPTION OF FAILURE	REMARKS
1							Flatwise Tension	
2	6 Ply 5209	HRP 3/16 Cell 4.0 #/ft3	Co-Cure	3940	985	NOT APPLICABLE		
3				3370	842			
4				3900	975			
5				3330	832			
6				3260	815			
1								
2		HRP 3/16 Cell 5.5 #/ft3		4000	1000			
3				4200	1050	1000		
4				3865	966			
5				4040	1010			
6				4115	1028			
1		HRP 3/16 Cell 4.0 #/ft3		1405	350		Compression of core	
2				1852	463	370		
3				1738	434			
1		HRP 3/16 Cell 5.5 #/ft3		3170	790			
2				3235	809	600		
3				2900	724			
1		HRP 3/16 Cell 4.0 #/ft		1380	232	180	Core Shear	Core in L Dir.
2				1418	239			
3				1308	220			
1				803	135	94		Core in W Dir.
2				799	135			
3				806	135			
1		HRP 3/16 Cell 5.5 #/ft3		2100	353			Core in L Dir.
2				2155	362	293		
3				2090	351			
1				1400	235			Core in W Dir.
2	6 Ply			1400	235			
3	5209		Co-Cure	1352	227	150		

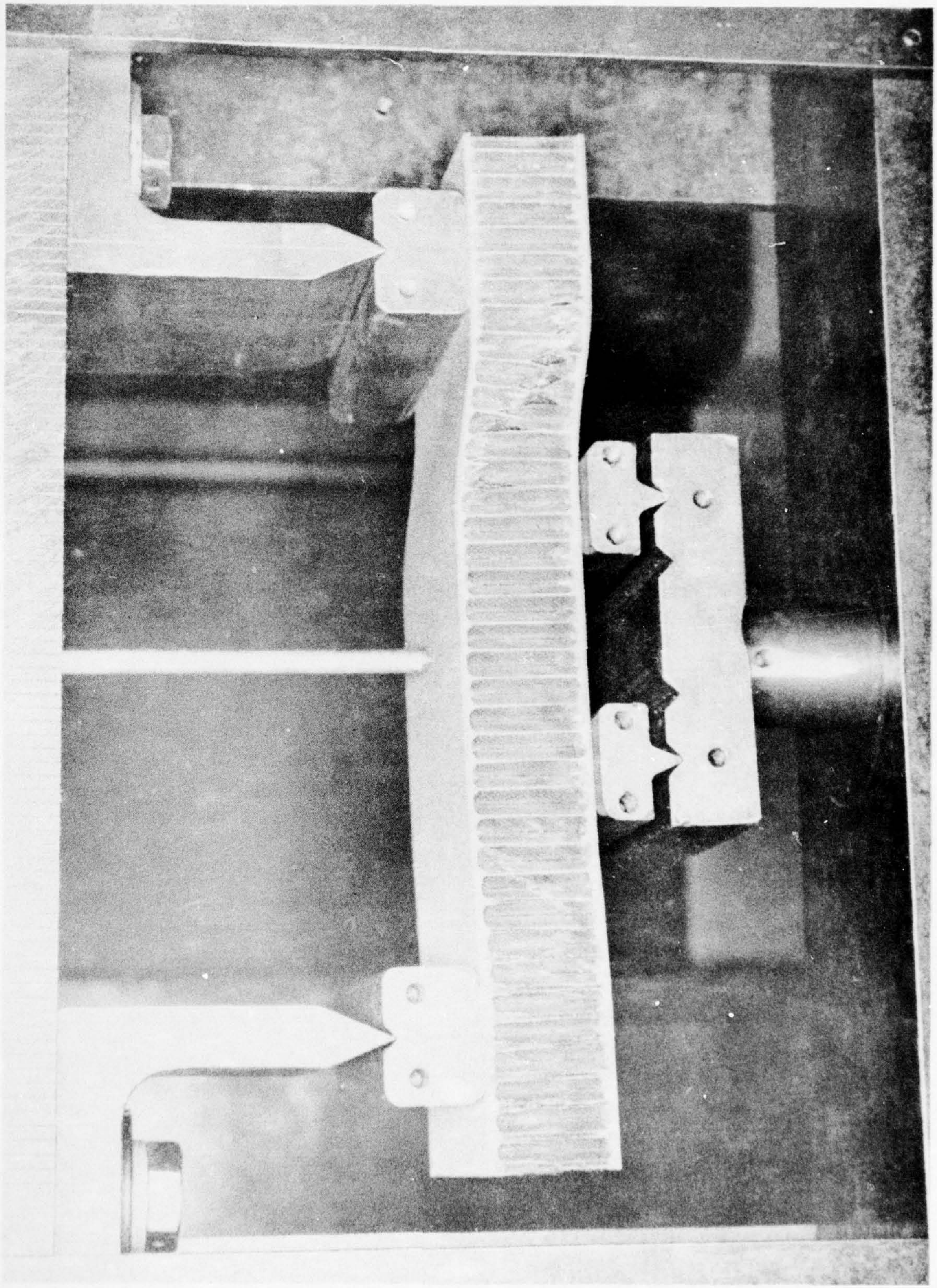


FIGURE 13 CORE SHEAR TEST (TR-140)

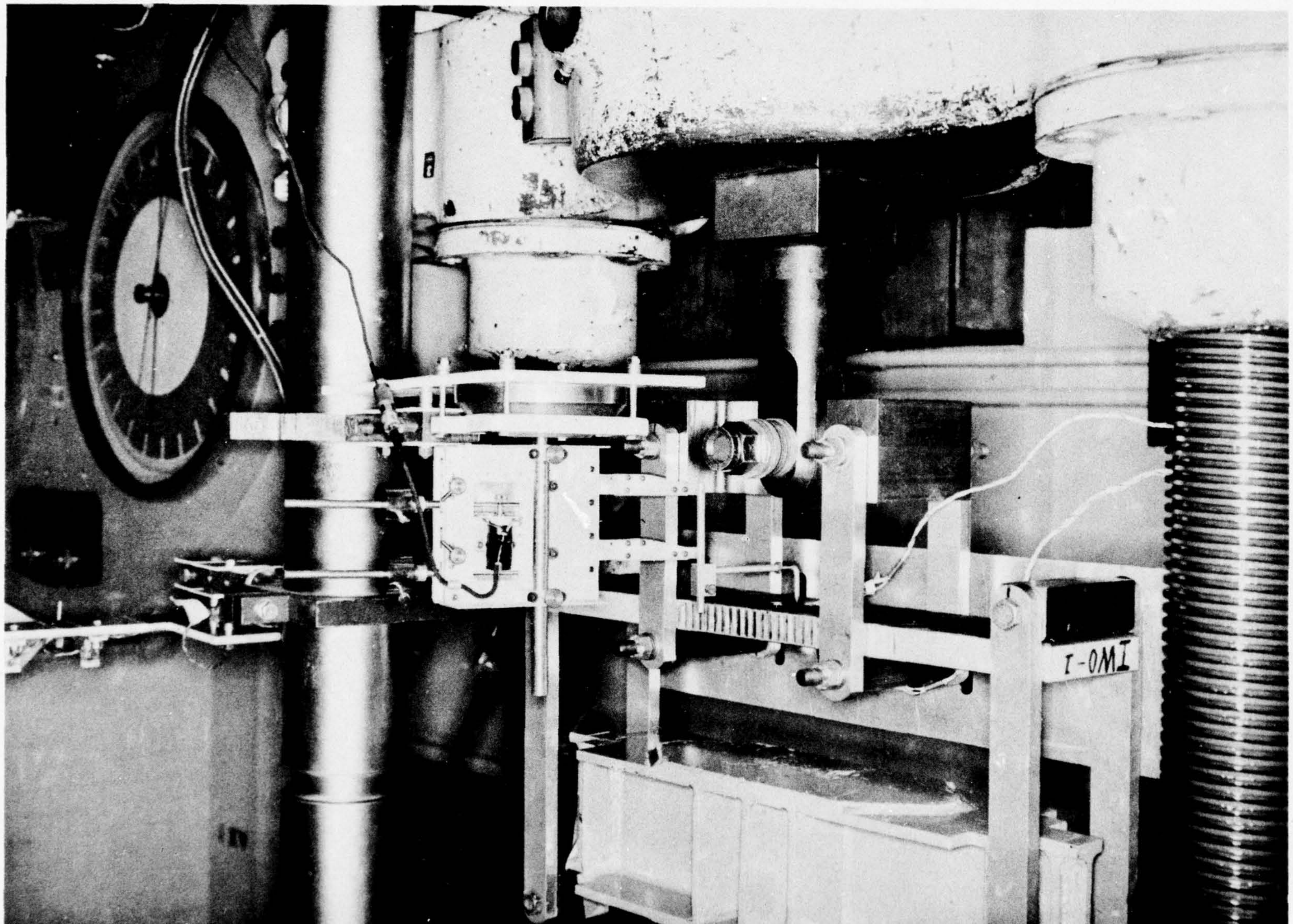


FIGURE 14 TEST SET-UP FOR FLEXURAL BEAM SPECIMENS (TR-141)

TABLE X TR141 FLEXURAL BEAM SPECIMEN TEST DATA

SPEC. NO.	FACE(1) (PLY)	LAYUP	FAB METHOD	NO. INSERTS	PREDICTED FAILING LOAD (LBS)	ACTUAL FAILING LOAD (LBS)	ε MAX IN/IN COMPRESSION	GROSS STRESS(3) KSI	NET STRESS(3) KSI	E x 10^6 (PSI)	FAILURE
IWO 1 IWO 2 IWO 3	6 UPPER 6 LOWER	$0_2 \pm 45, 0_2$	WET LAYUP - CO-CURED	NONE	4608	3275 3415 3460	.00793 .00678 .00901	82.2 85.7 86.8	- - -	NC (4) NC 13.8	UPPER FACE COMPRESSION
OWO 1 OWO 2 OWO 3	7 UPPER 7 LOWER	$0_2 +45, 0 -45, 0_2$		NONE	5719	4150 4305 4260	.00656 .00707 .00697	95.4 98.9 97.9	- - -	15.3 14.9 13.9	CORE UPPER FACE COMPRESSION
OW 6 OW 2 OW 5 OW 4	9 UPPER 7 LOWER	$0_4 +45, 0, -45, 0_2$ $0_2 -45, 0, +45, 0_2$		FOUR	2406	4130 4450 3845 3820	NA (2) .00549 NA NA	75.5 81.4 70.3 69.8	100.7 108.5 93.7 93.2	NC NC NC NC	
OW 1 OW 3	7 UPPER 9 LOWER	$0_2 +45, 0, -45, 0_2$ $0_4 -45, 0, +45, 0_2$		FOUR	2015	2580 3300	.00382 .00490	59.5 76.0	79.2 101.4	NC NC	
IW 1 IW 2 IW 3	7 UPPER 6 LOWER	$0_2, +45, 0, -45, 0_2$ $0_2, \pm 45, 0_2$		TWO	2015	2815 3340 3415	.00513 .00673 .00678	66.8 79.3 81.1	76.3 90.6 92.7	NC NC NC	CORE
IWO1-1 IWO1-2 IWO1-3 IOW1-4	tension specimens cut from laminate skin of IWO1		WET LAYUP - CO-CURED	NONE	5092 5167 4962 4512	4440 4850 4720 4060	(tension) .0085 .01013 .00963 .00885	104.6 112.6 114.1 108.0	- - - -	NC NC 12.9 13.2	TENSION
IWO2-1 IWO2-2 IWO2-3 IWO2-4	tension specimens cut from laminate skin of IWO2			NONE	4826 4656 5057 5370	3350 4460 4610 5390	(tension) .00775 .00995 .01010 .0089	83.3 115.0 112.1 120.4	- - - -	NC 12.5 11.7 13.5	
BIW-1 BIW-2 BIW-3 BIW-4 BIW-5 BIW-6	8 UPPER 7 LOWER	$0_3 +45, 0, -45, 0_2$ $0_2 -45, 0, +45, 0_2$		TWO	4800	2900 3470 3005 3020 2740 3180	.00407 .00616 NA NA NA NA	66.1 79.1 68.5 68.8 62.4 72.5	75.5 90.4 78.3 78.6 71.3 82.9	14.48 14.48 NC NC NC NC	UPPER FACE COMPRESSION
BOW-1 BOW-2 BOW-3 BOW-4 BOW-5 BOW-6	10 UPPER 8 LOWER	$0_4, +45, 0_2, -45, 0_2$ $0_2 -45, 0_2, +45, 0_2$		FOUR	5500	3825 3315 3750 3735 3950 4110	.004476 NA NA NA .004768 NA	63.5 55.1 62.3 62.0 65.6 68.3	84.7 73.5 83.1 82.0 87.5 91.0	15.8 NC NC NC 15.8 NC	
BOWO-1 BOWO-2 BOWO-3	7 UPPER 7 LOWER	$0_2 +45, 0, -45, 0_2$ $0_2 -45, 0, +45, 0_2$	Pre-cured Skins	NONE	6066	5945 5415 6540	NA NA NA	136.6 124.4 150.3	- - -	NC NC NC	
BFOW-1 BFOW-2 BFOW-3	10 UPPER 8 LOWER	$0_4, +45, 0_2, -45, 0_2$ $0_2 -45, 0_2, +45, 0_2$	Wet layup co-cured	FOUR	Cycled from 13.6 KSI to -6.8 KSI Design 40,000 cycles (2 lives)						2,520,000 cycles + 2,532,000 cycles + 7,801,000 cycles +

(1) UPPER FACE IN COMPRESSION (2) NA - NOT AVAILABLE, NO GAGE (3) UPPER FACE STRESS BASED ON LOAD (4) NC - NOT CALCULATED
PLY THICKNESS OF .0050

had pre-cured skin to reduce laminate dimpling. These specimens show higher failing loads and failing stresses that are close to predicted values.

Specimens BIW and BOW indicated that adequate capability was available in full scale components to sustain design loads.

Three specimens were built (BFOW-1 thru -3) to evaluate fatigue capability. These specimens show capability of sustaining 100 + lives, indicating a high probability that the full scale component would meet the fatigue requirements.

TR-142 Hinge Fitting/Sandwich Panel Tests

Both tension and compression loads were applied to three (3) spoiler planks through a simulated hinge fitting as shown in Figure 15. The specimens were tested to limit load in tension and failing load in compression.

Two of the specimens failed on the tension face. Stress level based on load was 100.9 and 96.2 KSI. Both failures occurred at the edge of the fitting. The third specimen failed in the core at a laminate flexural stress, based on load, of 97.5 KSI. The higher failing stress was attributed to a local load redistribution because of the presence of the fitting.

TR-147 Panel Edge Closeout Test

The flexural strength characteristics of a typical sandwich panel with close-out edge members and an eight ply upper and lower surface was determined by this test.

Three specimens were fabricated and static tested to failure as shown in Figure 16. Figure 17 shows a failed specimen. Table XI summarizes the specimen configurations and test results.

Examination of the test data and the failed specimens revealed two things.

(1) All specimens failed in the compression face at a lower value than was predicted. This is attributed to face dimpling.

(2) Laminate edge member shear stress was low, indicating that the vertical load is reacted by the honeycomb core.

TR-150 Compression Properties of Co-Cured Sandwich Specimens

This test was conducted to determine the compressive modulus when the wet laminate is co-cured to the HRP core. It was found that the modulus of the co-cured specimen was from 12.5 to 17.5% lower than the design modulus. Thus,

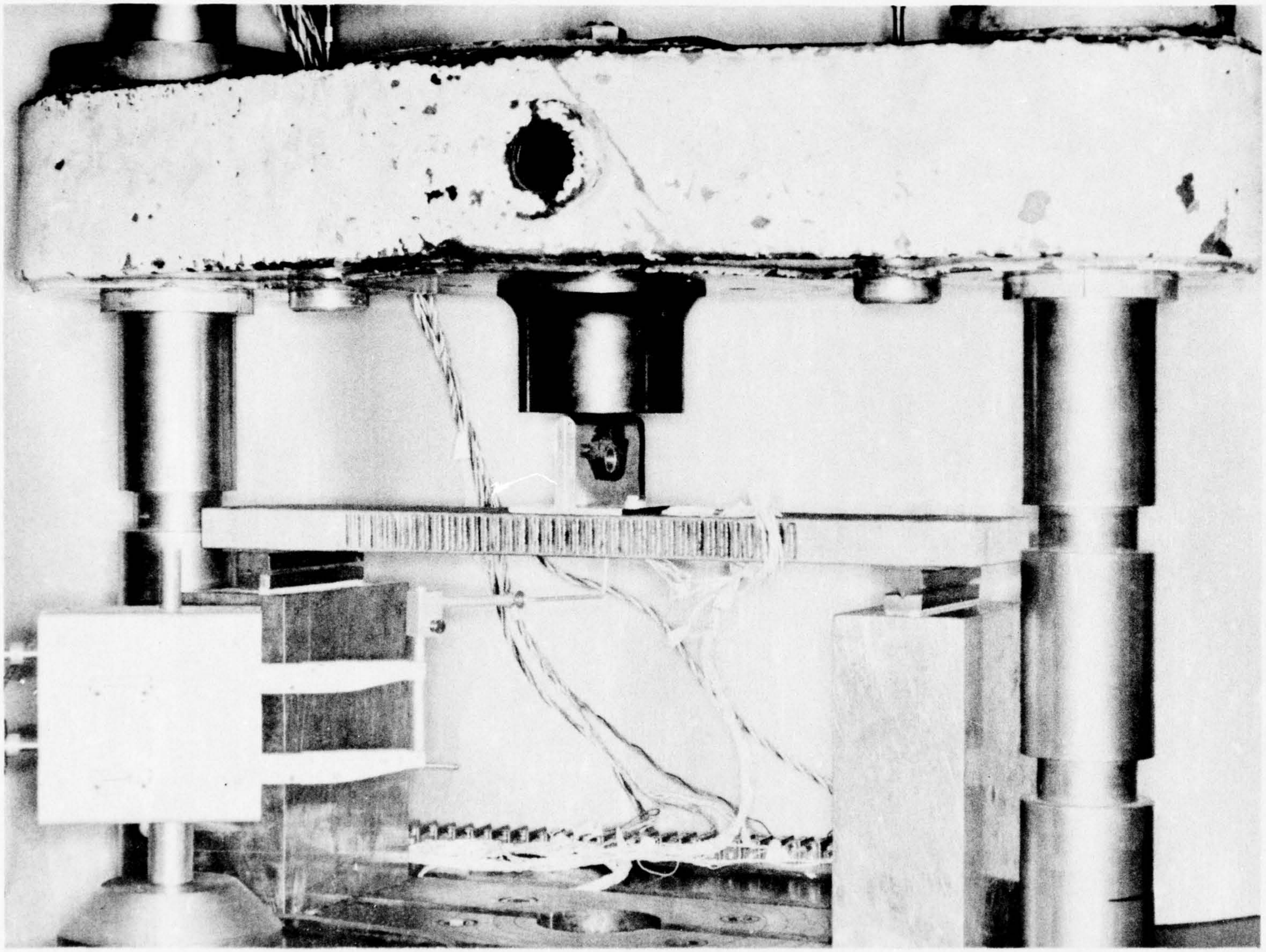


FIGURE 15 HINGE FITTING/SANDWICH PANEL SPECIMEN (TR-142)

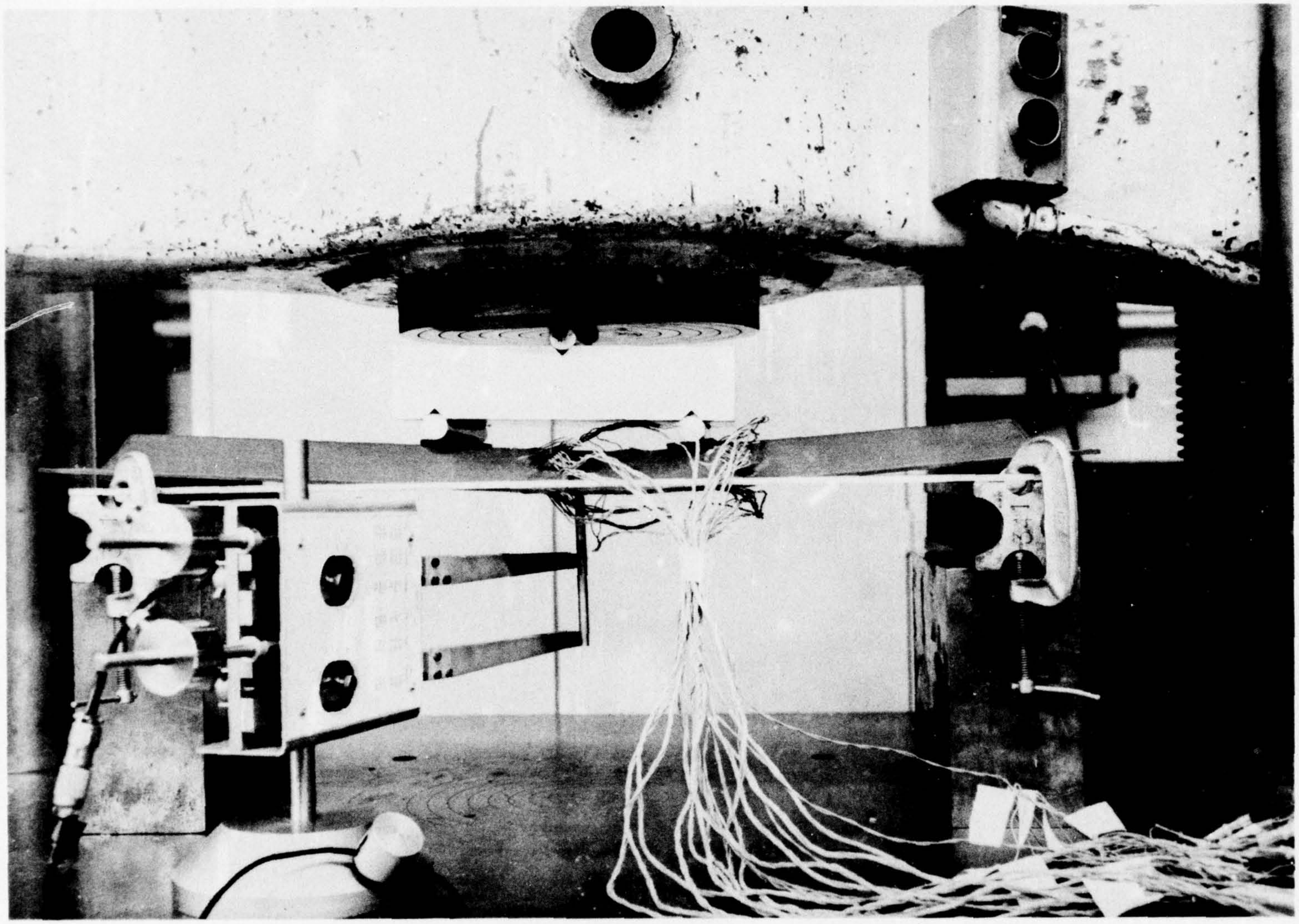


FIGURE 16 TEST SET-UP FOR PANEL WITH EDGE CLOSEOUT (TR-147)

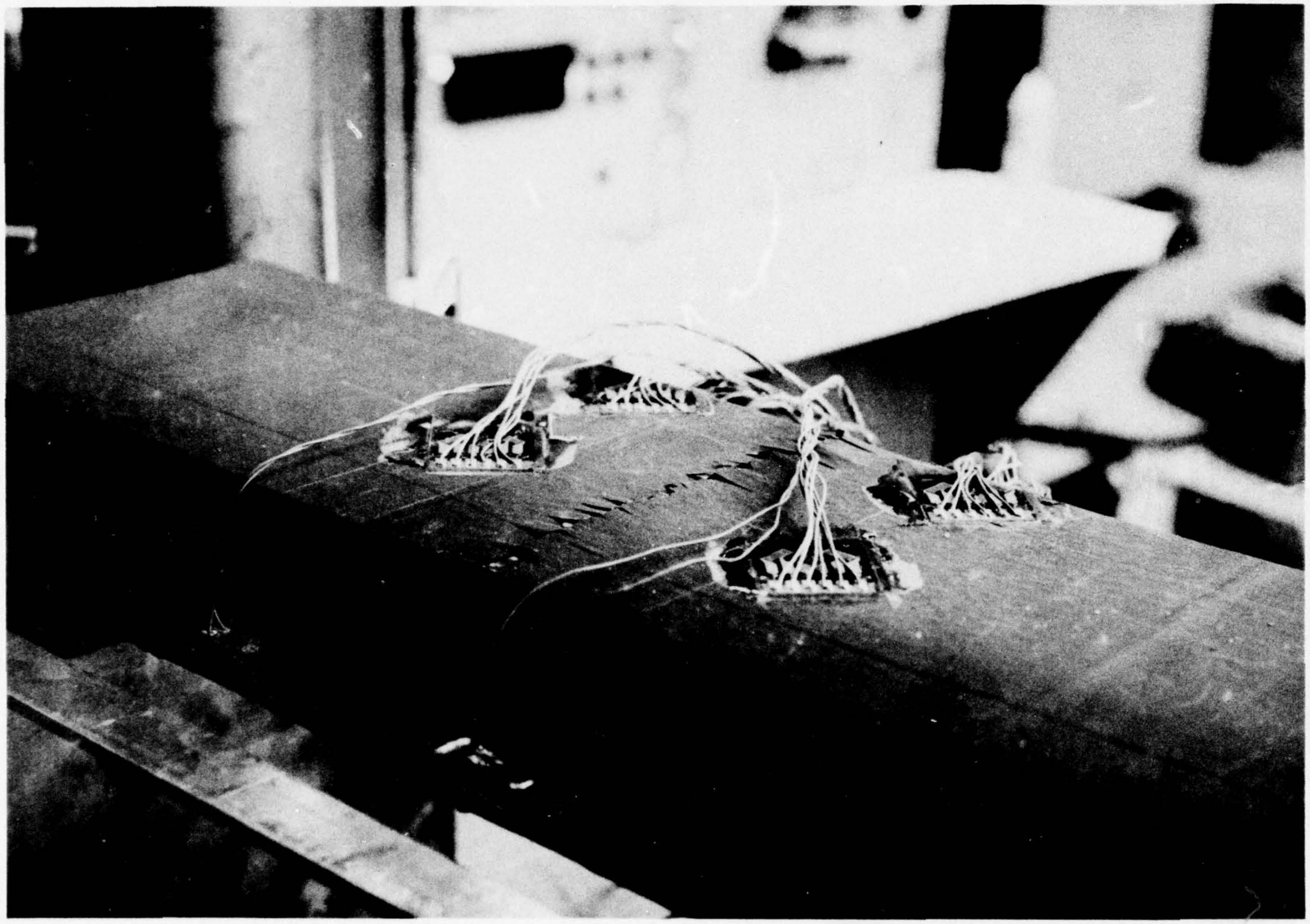


FIGURE 17 FAILED TEST SPECIMEN WITH EDGE CLOSEOUTS (TR-147)

TABLE XI TR147 STRENGTH EVALUATION OF SANDWICH PANELS WITH EDGE CLOSEOUT

SPEC. NO.	FACE (PLY) [1]	LAYUP	FAB. METHOD	PREDICTED FAILING LOAD (LBS.)	ACTUAL FAILING LOAD (LBS.)	GROSS STRESS TENSION (KSI)	GROSS STRESS COMP. (KSI)
1	8 UPPER 8 LOWER	$0_2, -45, 0_2, +45, 0_2$ $0_2, +45, 0_2, -45, 0_2$	WET LAYUP - CO-CURED	6200	5165	51.6	88.9
2	8 UPPER 8 LOWER	$0_2, -45, 0_2, +45, 0_2$ $0_2, +45, 0_2, -45, 0_2$		6200	4540	45.3	78.1
3	8 UPPER 8 LOWER	$0_2, -45, 0_2, +45, 0_2$ $0_2, +45, 0_2, -45, 0_2$		6200	5075	50.7	87.3

(1) UPPER FACE IN COMPRESSION

an extra ply of material was added to the upper and lower faces of the spoiler. Suspecting laminated dimpling between cell walls, other specimens were run with precured (and thus pre-stabilized) core. Testing showed modulus values equal to or greater than the design values.

Table XII summarizes the test results, and Figure 18 shows the test set up.

Weight

Based on the completed design drawings and data available from production sources, a weight comparison of the graphite composite spoiler and the metal design was made and is presented in Table XIII.

TABLE XII TR 150 COMPRESSION TEST SPECIMEN RESULTS

SPECIMEN	FACE (PLY)	ORIENTATION	MAT'L	CORE TYPE	FAB PROCEDURE	FAILING LOAD (LB)	F_{cu} DESIGN PSI	FAILING STRESS PSI	$E_c \times 10^6$ TEST PSI	$E_c \times 10^6$ DESIGN PSI	FAILURE
5A	5	$0,\pm45,0_2$		HRP	CO-CURE	6035	110,000	60,350	10.40	12.6	Compression
5B	5			3/16 Cell		6010		60,010	11.40		At Base
5C	5			$4.0\#/Ft^3$		4980		49,800	13.20		
6A	6	$0_2,\pm45,0_2$				7540	122,600	62,833	13.72	13.7	
6B	6					8120		67,667	13.90		
6C	6					7620		63,500	15.00		
7A	7	$0_2+45,0,-45,0$				7140	129,600	51,000	12.70	14.5	
7B						9490		67,785	13.30		
7C					CO-CURE	8470		60,500	12.50		
7D					Stabilized	11060		78,810	15.07		
7E					CORE	13120		93,686	14.69		
7F						13020		92,800	14.47		
7G			5209 - T300		Pre-cured	12920		91,598	15.53		
7H					Faces	14120		100,455	14.47		
7I	7					11670		82,778	15.12		

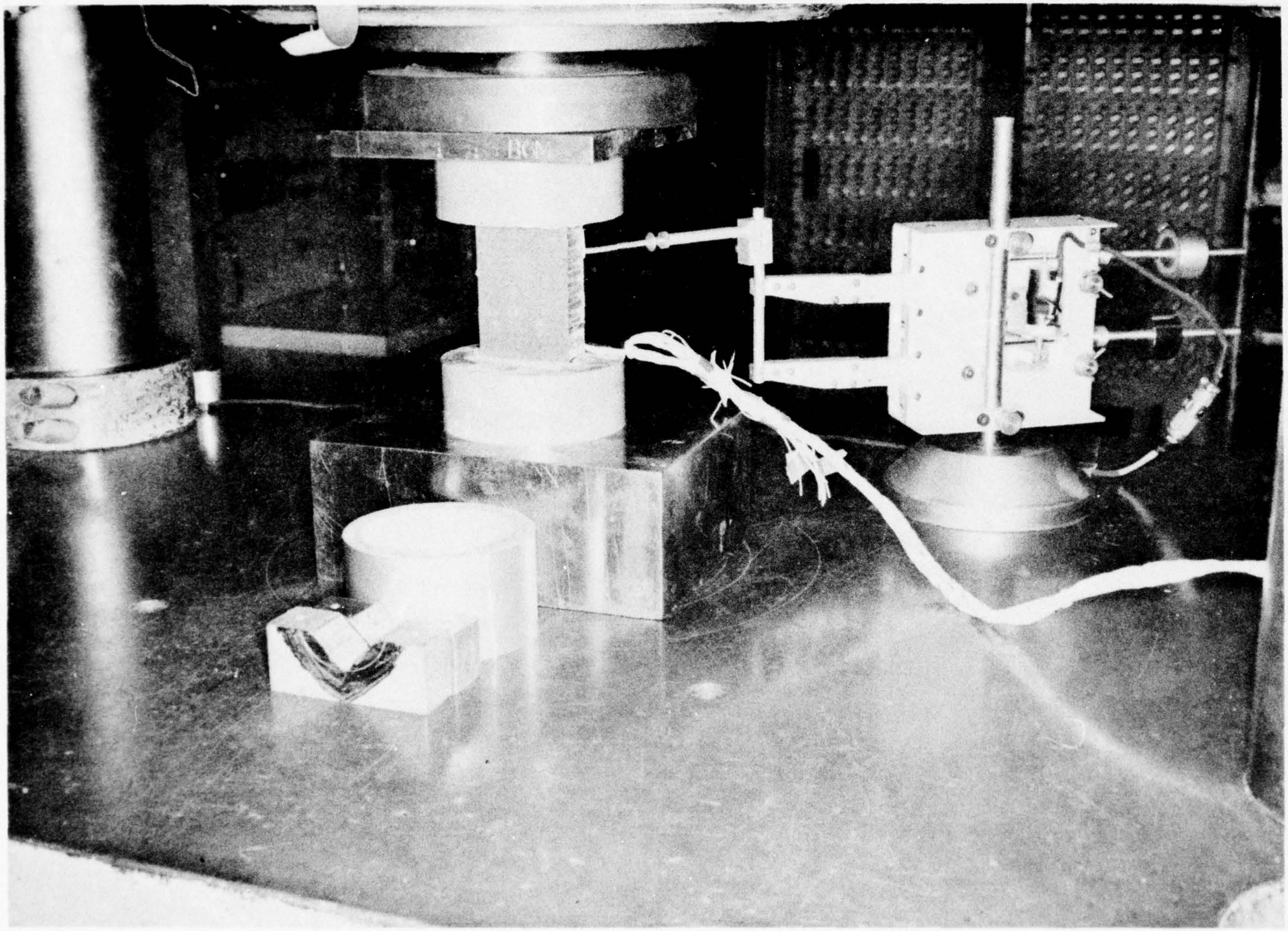


FIGURE 18 COMPRESSIVE TEST SET-UP (TR-150)

TABLE XIII SPOILER WEIGHT COMPARISON
(WEIGHT IN POUNDS)

COMPONENT	METAL	CALC. COMP. WT.	ACTUAL COMPONENT WEIGHT				
			MFG. DEV.	STATIC NO. 1	STATIC NO. 2	STATIC NO. 3	FATIGUE
SPOILER PLANK	12.70	8.40	8.43	8.31	8.34	—	—
% SAVINGS	—	33.86	33.62	34.57	34.33	—	—
FINISHED SPOILER*	16.69	12.28	—	11.59	11.65	12.09	12.05
% SAVINGS	—	26.42	—	30.56	30.20	27.56	27.80
			AVERAGE % WEIGHT SAVINGS= 29.03 %				

* INCLUDES HINGES, SEALS, HARDWARE

SECTION 3

MANUFACTURING DEVELOPMENT AND FABRICATION

The manufacturing development portion of the program has covered tooling, a spoiler manufacturing plan and fabrication of manufacturing development specimens, design verification specimens, three static test spoiler assemblies, and one fatigue test spoiler assembly.

Two types of templates were used for spoiler fabrication, (1) mylar templates, and (2) aluminum trim templates. A glass epoxy molding tool was designed and fabricated for spoiler assembly and cure. Tab stiffener sub-assemblies were cured using a .38 thick flat aluminum plate as a tool.

To establish techniques for fabrication of the four deliverable spoiler assemblies four types of manufacturing development specimens were made. Three specimens were made to determine the best method for lightning protection screen attachment to the spoiler lower skin. Six specimens were manufactured to establish a satisfactory method for honeycomb core edge stabilization in order to resist core collapse due to autoclave cure pressure. Two specimens were made to be used as standard defect specimens for ultrasonic immersion testing as well as determination of the correct resin bleeder material to be used between the tool and the spoiler. The fourth specimen represented the outboard end of the spoiler with one hinge tab and edge closeouts on all four sides. This specimen rendered proof of tooling concept prior to lay-up and cure of the manufacturing development spoiler. Table XIV summarizes the results of the manufacturing development specimens.

TABLE XIV - MANUFACTURING DEVELOPMENT SPECIMENS

SPECIMEN NUMBER	REQUIRED DATA	RESULTS
MDS-1	Lightning protection screen attachment	Layer of adhesive between screen and lower skin
MDS-2	Honeycomb core edge stabilization	350F curing phenolic resin
MDS-3	NDT data & lower resin bleeder requirements	1. Minimum detectable delamination = .50 dia 2. With screen and resin bleeder required
MDS-4	Proof of tooling concept	Concept satisfactory

A spoiler subassembly was fabricated as confirmation of the manufacturing planning, checkout of the molding tool and processing parameters. No final assembly operations were carried out for this article, i.e., no hinge assemblies or trailing edge seal were installed. Provisions for these items were included by installation of the threaded inserts and drilling and countersinking the seal attach holes. Fabrication of the manufacturing development article was in accordance with the following fabrication sequence.

I. Core Stabilization
   A. Machine core segments to size
   B. Sand .125 R per engineering drawing
   C. Machine lower bevels
   D. Clean core
      1. Solvent flush
      2. Dry (1 hr. @ R.T.)
      3. Wrap in clean Kraft paper
   E. Stabilize core
      1. Stabilize periphery of core by dipping in SC 1008 phenolic resin
      2. Cure in oven (350F - 1 hr.)
      3. Wrap in clean Kraft paper

II. Tab Stiffener Assembly (Separate Operation)
   A. Prepare tool (flat plate) for bonding
      1. Solvent clean
      2. Apply release coating
   B. From broadgoods
      1. Lay up one (10 inch x 7 inch) 4 ply laminate (per 78-002553)
      2. Trim one piece HRP core, 5 x 7 inches
         a. Saw 7 inch edges at 30° bevel
         b. Clean core
            (1) Solvent flush
            (2) Dry (1 hr. @ R. T.)
            (3) Wrap in clean Kraft paper

3. Trim film adhesive, specification 207-8-415, type II, grade 10 to match laminate
    a. Apply adhesive
    b. Remove backing film
4. Apply core to adhesive per engineering drawing

C. Prepare for cure (specification 208-8-3), apply:
    1. Peel ply
    2. Separator film
    3. Bleeder
    4. Vacuum bleeder
    5. Breather
    6. Bagging film

D. Autoclave cure
    1. Door close to door open - 4 hrs.

E. Debag

F. Machine -22 and -23 (78-002553) from stock produced by B thru E above.

G. Clean -22 and -23
    1. Solvent clean
    2. Dry (160F for 1 hr.)
    3. Wrap in clean Kraft paper

III. Lower Skin Assembly

A. Prepare tool for bonding
    1. Solvent clean
    2. Apply release film
    3. Apply peel ply

B. Template trim 120 mesh screen to size

C. Clean screen (CVA 8-51, Method II)
    1. Vapor degrease
    2. Rinse
    3. Alkaline clean
    4. Rinse
    5. Acid clean
    6. Rinse
    7. Protect (paper wrap)
    8. After cleaning handle screen only when using cotton gloves

D. Apply screen in molding tool

E. Apply film adhesive, specification 207-8-415, type II, grade 10

   1. Template trim

   2. Place on assembly

   3. Remove backing film

F. Hand lay up lower skin (Ref Figure 19)

   1. Trim plies number 1 thru 9 (one template)

   2. Place lower skin on tool (use transfer template)

      a. Remove mylar backing

G. From broadgoods (38 inches x 90 inches - 45° orientation)

   1. Trim ply numbers 10 thru 18 (17 templates) (Ref Figures 20 thru 24)

   2. Apply plies, in proper sequence, on tool

      a. Remove Mylar backing

IV. Lower Skin/Core Subassembly

A. Apply film adhesive, specification 207-8-415, type II, grade 10, to lower skin to core faying surface

   1. Remove backing film

B. Place core segments onto lower skin

   1. Use adhesive foam specification 207-8-408, type III, for core splice (2 places)

C. Apply film adhesive, specification 207-8-415, type II, grade 10 to upper surface of core

   1. Remove backing film

V. Upper Skin Assembly

A. Hand lay up upper skin (Ref Figure 25)

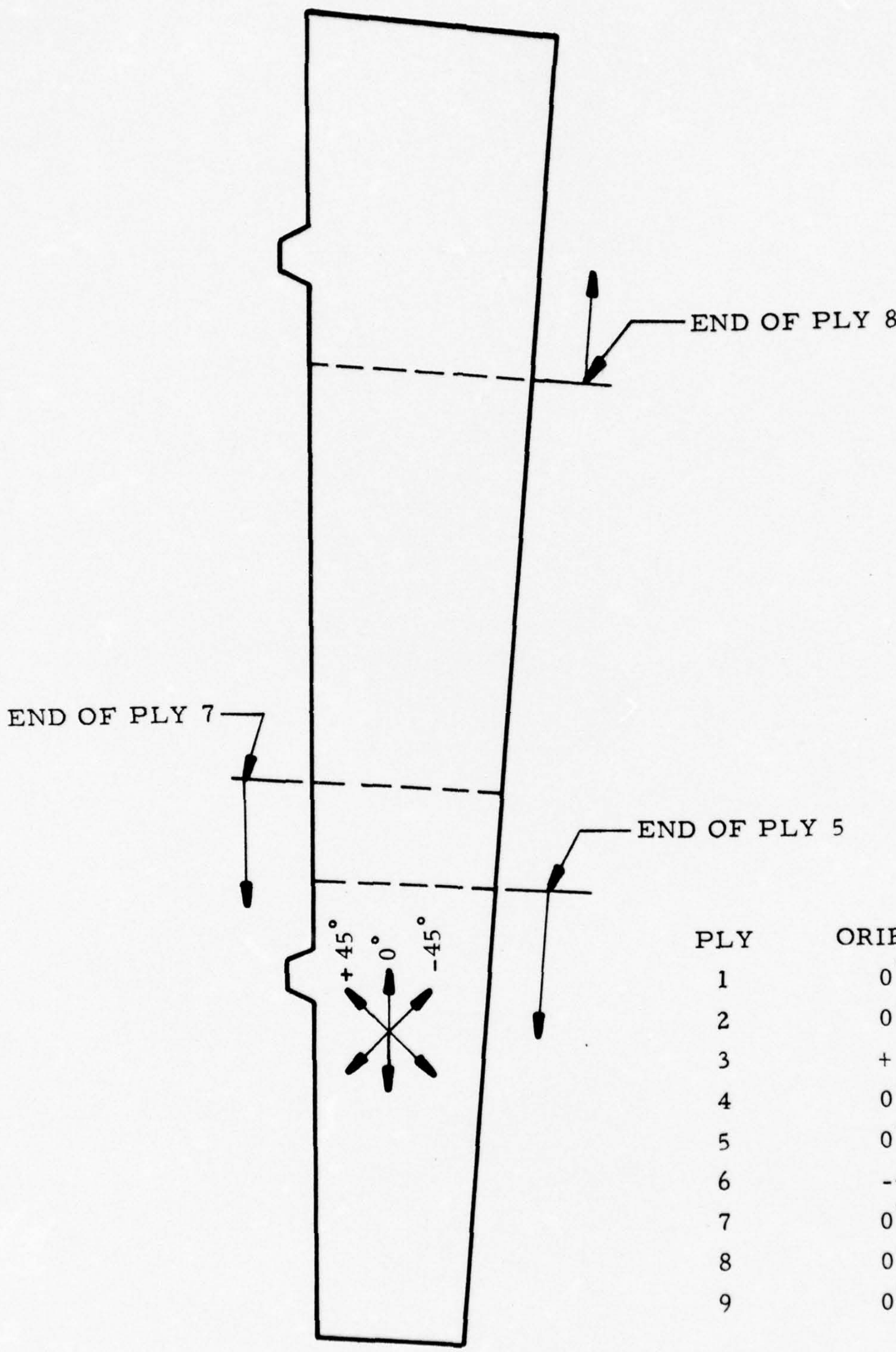
   1. Trim ply numbers 1 thru 9 (one template)

   2. Trim plies for upper skin doublers (three templates)

   3. Apply to tool (use transfer template) butt joint corners per engineering drawing 78-002553

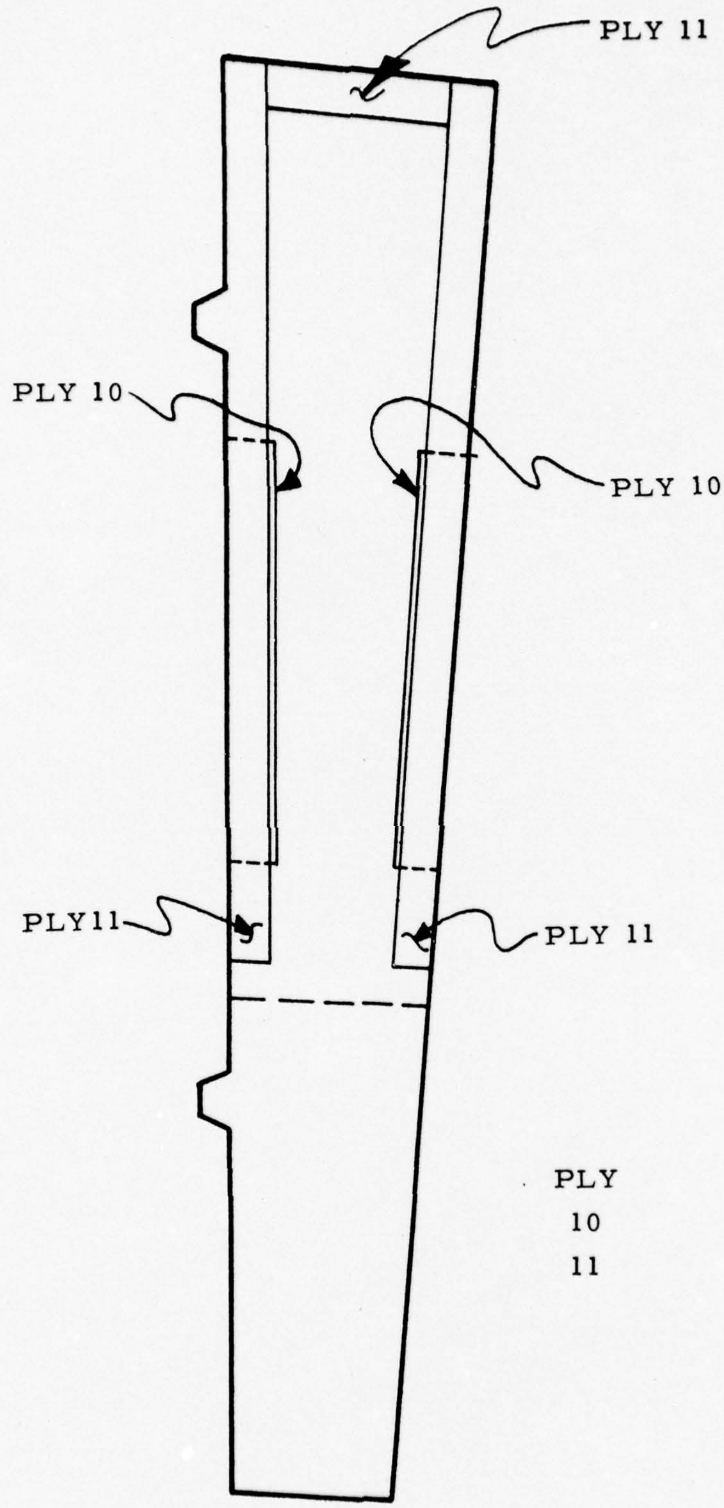
   4. Apply upper skin doubler ply stack on upper skin (use transfer templates) (Ref Figure 26)

   5. Protect from contamination



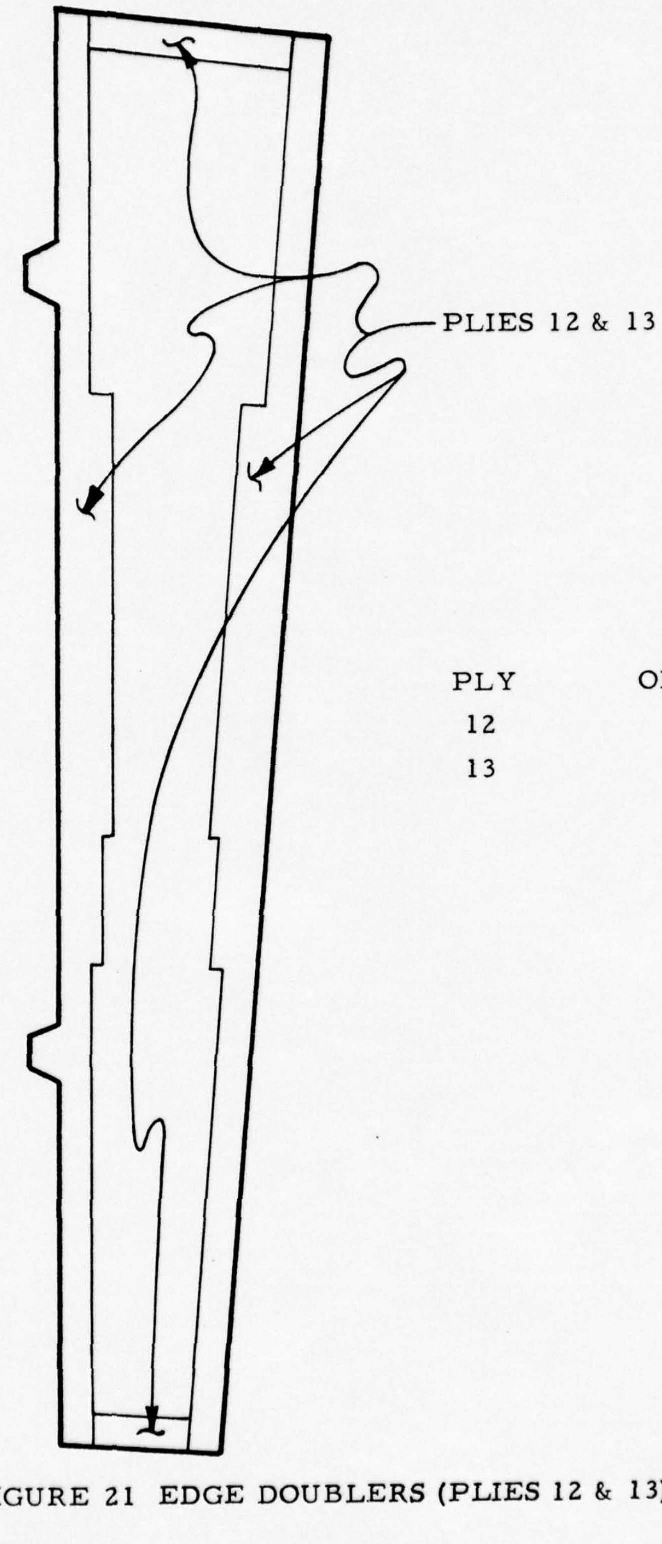
PLY	ORIENT.
1	0°
2	0°
3	+ 45°
4	0°
5	0°
6	-45°
7	0°
8	0°
9	0°

FIGURE 19 LOWER SKIN LAY-UP



PLY	ORIENT.
10	+45°
11	-45°

FIGURE 20 EDGE DOUBLERS (PLIES 10 & 11)



PLY	ORIENT.
12	$+45^{\circ}$
13	-45°

FIGURE 21 EDGE DOUBLERS (PLIES 12 & 13)

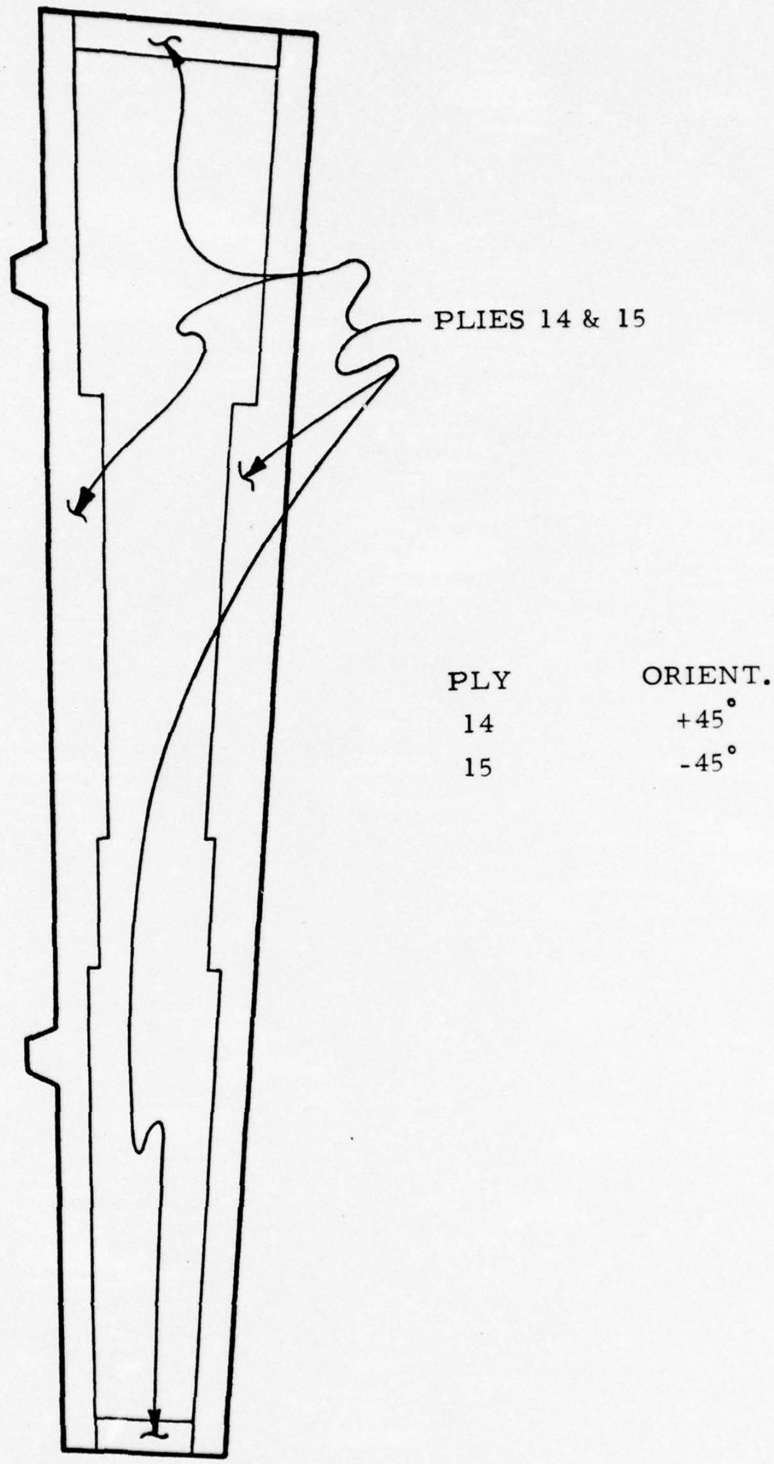
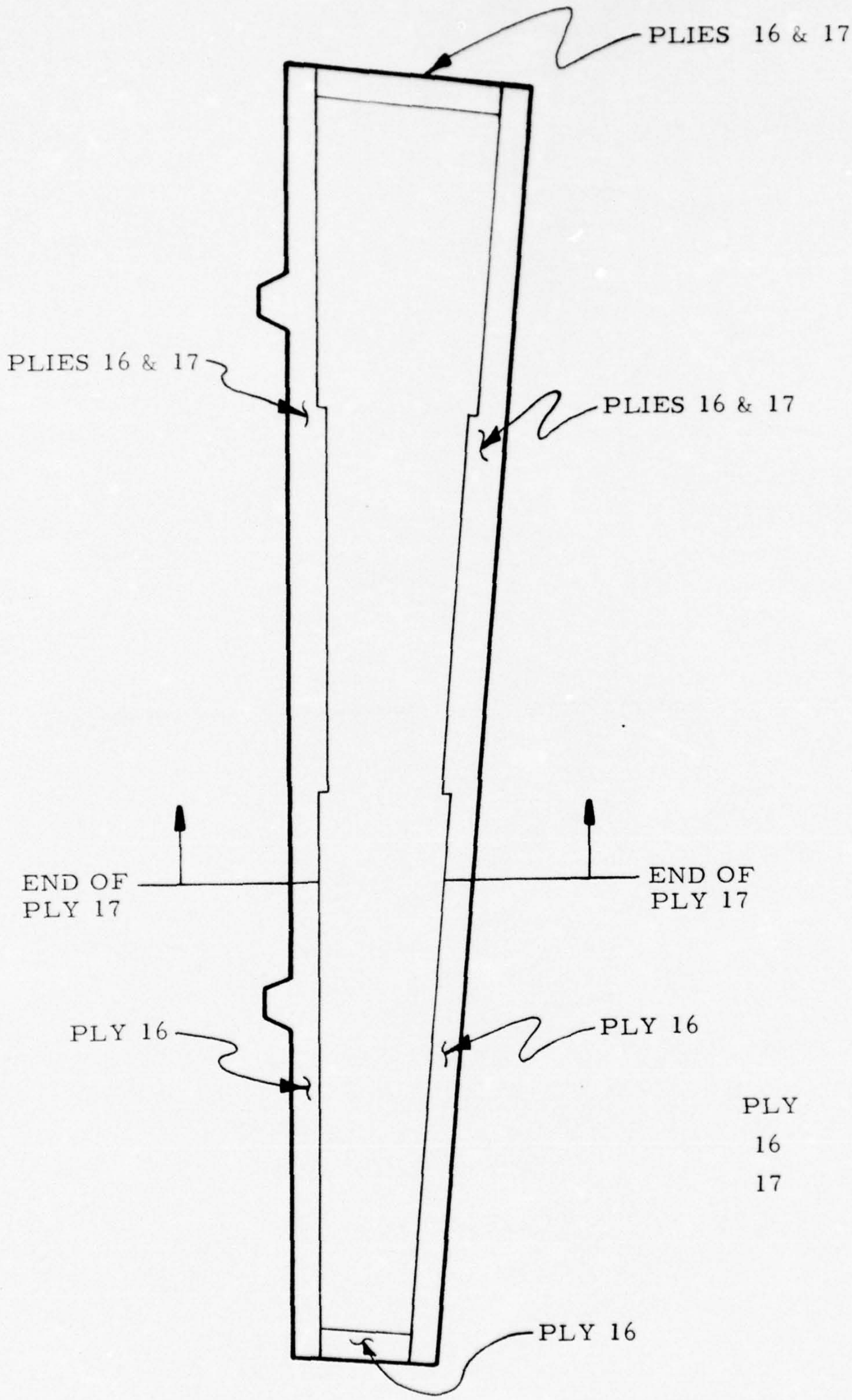


FIGURE 22 EDGE DOUBLERS (PLIES 14 & 15)



PLY	ORIENT.
16	+45°
17	-45°

FIGURE 23 EDGE DOUBLERS (PLIES 16 & 17)

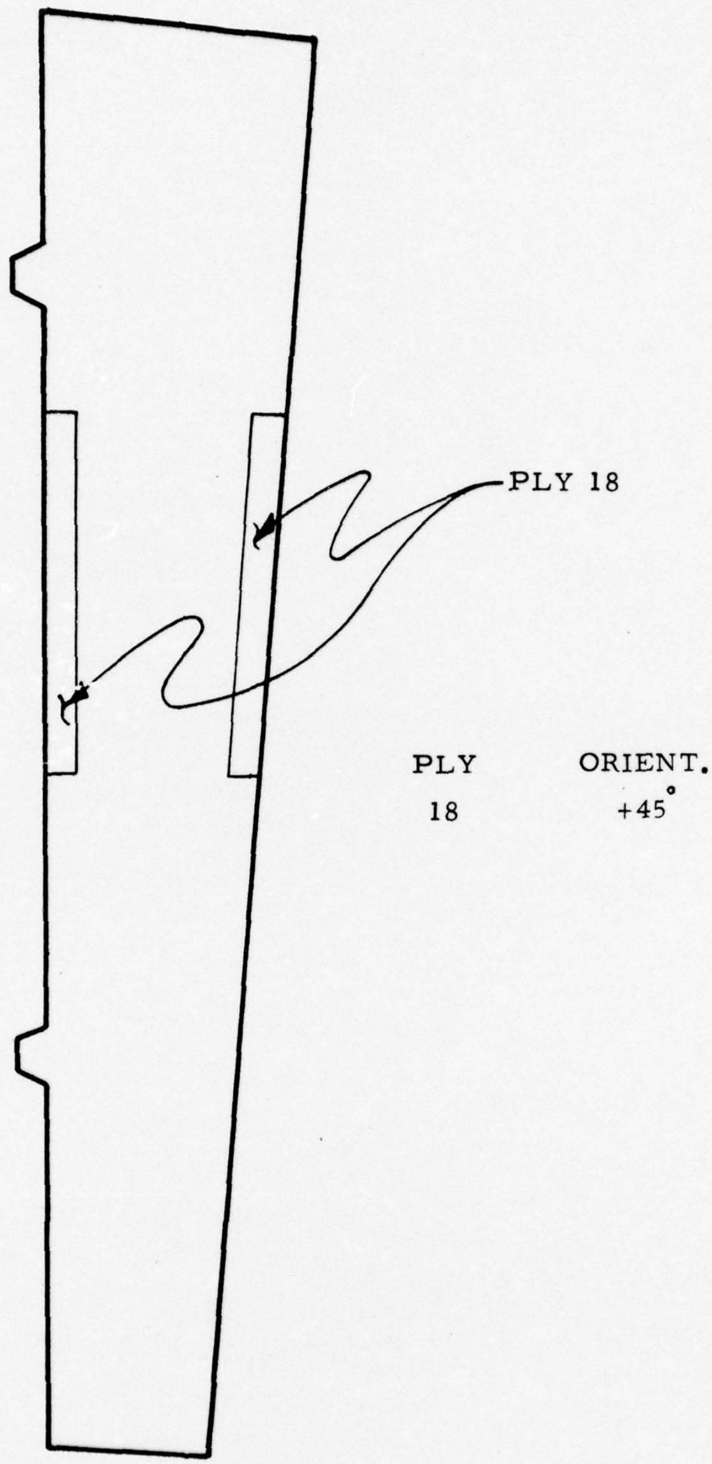
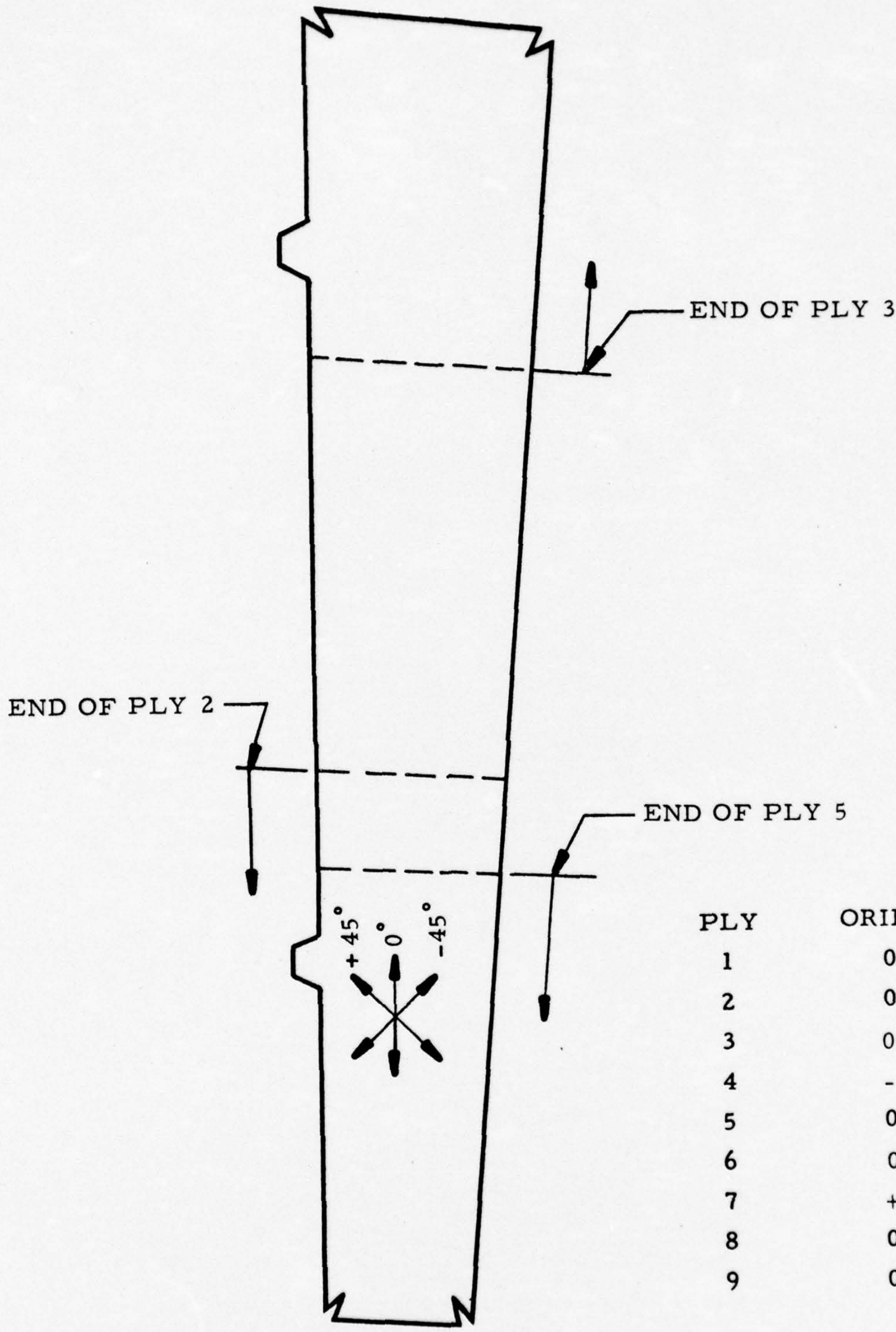
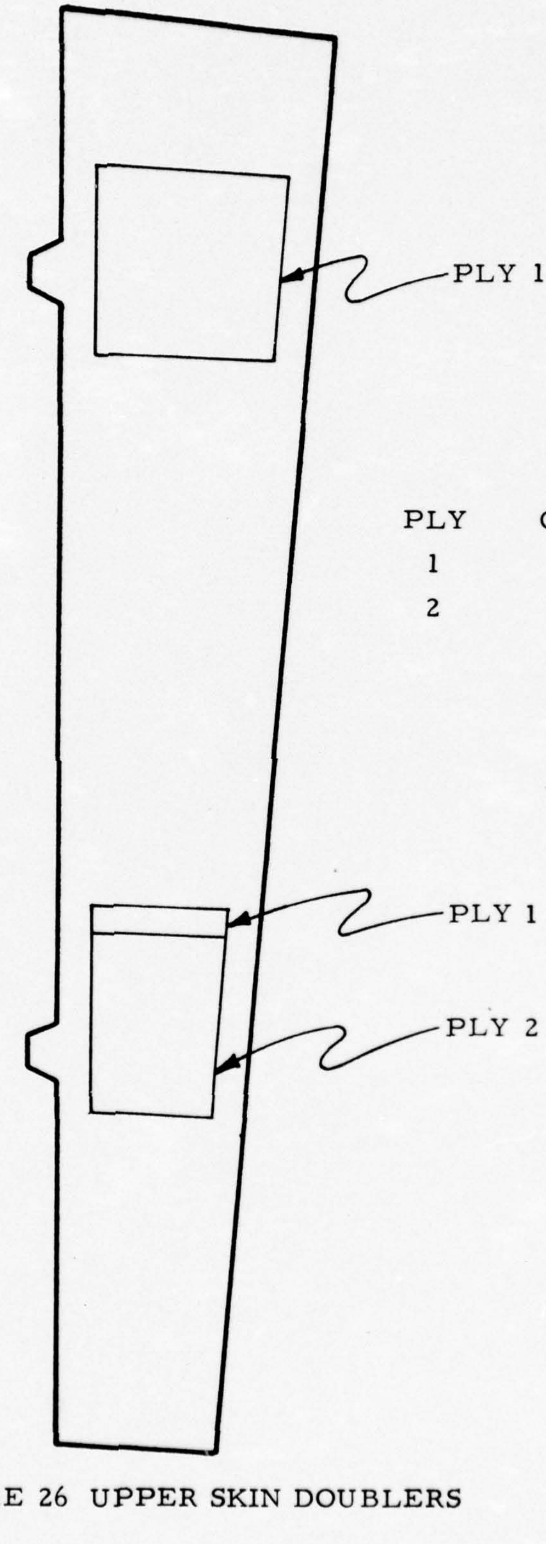


FIGURE 24 EDGE DOUBLERS (PLY 18)



PLY	ORIENT.
1	0°
2	0°
3	0°
4	-45°
5	0°
6	0°
7	+45°
8	0°
9	0°

FIGURE 25 UPPER SKIN LAY-UP



PLY	ORIENT.
1	0
2	0

FIGURE 26 UPPER SKIN DOUBLERS

VI. Spoiler Assembly

A. Apply film adhesive, specification 207-8-415, type II, grade 10, to -22 and -23 (reference Item II)

B. Position -22 and -23 on assembly

C. Prepare for cure, specification 208-8-3

1. Similar to item II.C.1 thru 6

D. Autoclave cure

1. Door close to door open - 4 hrs.

E. Debag

F. Rough trim (remove excess resin and molding flash)

G. NDT(24 -36 hrs. turn around)

H. Machine to final size (leave tooling tab at each end)

I. Install hinge inserts

1. Using production hinges and shims

a. Load hinges and spoiler in assembly tool

b. Pilot holes in spoiler (inner skin only)

c. Install inserts

(1) .5 diameter hole in spoiler inner skin

(2) Under cut core

(3) Clean core

(a) Solvent flush

(b) Dry (160F for 1 hr.)

(4) Using paste adhesive, specification CVA 8-405, type VI

(a) Mix adhesive

(b) Fill cavity (1/2 full)

(c) Install inserts

(d) Fill cavity

(e) Cure (8 hrs. @ R. T.)

d. Using sealant, specification CAV 6-579, seal

(1) Seal edges of -22 and -23

J. Seal Attach Provisions

1. Drill 66 holes per engineering drawing

K. Final Inspect

Process control specimens were made for the manufacturing development article. These specimens are fabricated at the same time, with the same materials, and under the same procedures as the spoiler. These provided a baseline for future process control specimens and give an idea of the quality of the material and procedures. In this case two extra sets of process control specimens were fabricated. One set was made with a bonded aluminum screen. The second set was made with scrim cloth between the specimen and the screen so that the screen could be removed after curing. The purpose of these specimens was to check the weakening effect due to bleed off of resin into the screen. This bleed off of resin raises the fiber volume and therefore it was expected that the screen would decrease the short beam shear strength and increase the modulus. Results concur with prediction as can be seen in Table XV.

TABLE XV - PROCESS CONTROL SPECIMENS - MANUFACTURING DEVELOPMENT SPOILER

	PEEL PLY BOTH SIDES	SCREEN WITH SCRIM CLOTH	WITH BONDED SCREEN
f_{sa}	13,666 *	12,511	11,063
F	231,469	228,091	280,846
E	18.03×10^6	21.21×10^6	26.11×10^6

* All values are averages

The spoiler was then cut into three basic types of specimens. These consisted of flexural beam specimens, tensile specimens, and potted insert specimens. Three flexural beam specimens, twelve (12) tensile specimens, six (6) from the upper skin and six (6) from the lower skin, and two (2) potted insert specimens were fabricated from the full scale component. These were cut from the spoiler as shown in Figure 27.

The three flexural beam specimens were four point loaded as shown in Figure 28A. The load concentrations made it necessary to neck down specimens A & B as shown in Figure 28B. This necking down of the specimen assured that the beam would fail in flexure. Specimen C could not be necked down because of the potted inserts. This beam was prepared in order to test the weakening effect of the potted inserts. The general area of the inserts was strengthened with

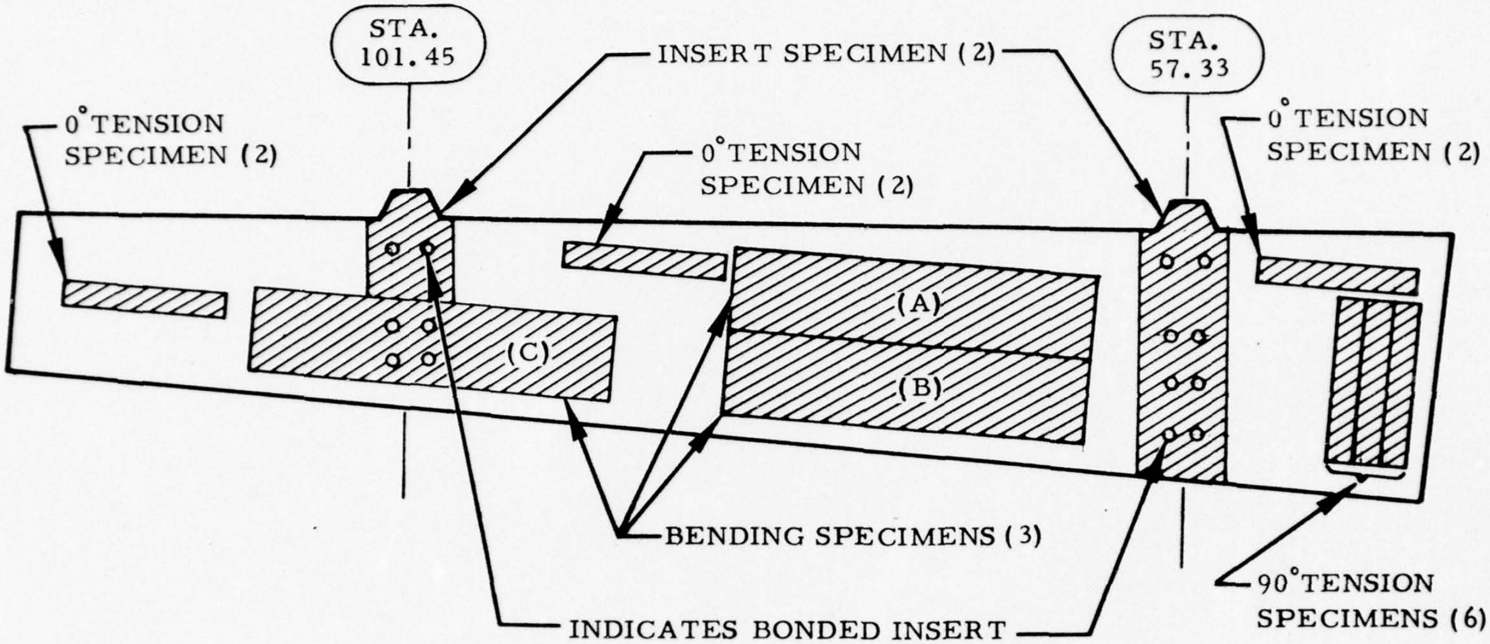
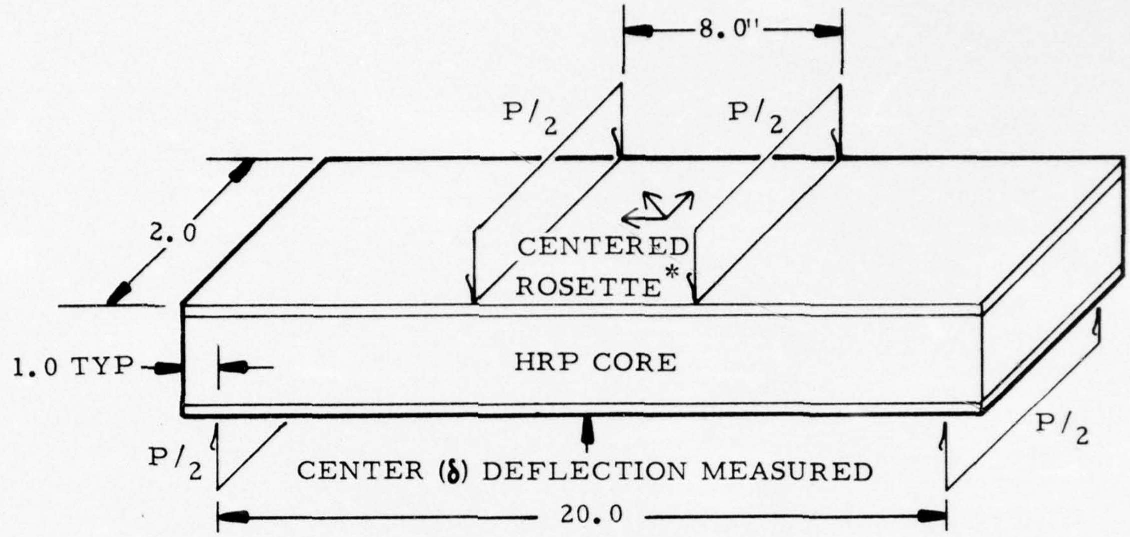


FIGURE 27 SPECIMEN LOCATIONS - MANUFACTURING DEVELOPMENT SPOILER



* INSTALL ROSETTE ON ONE SPECIMEN, UPPER & LOWER SURFACE

FIGURE 28A FLEXURAL BEAM SPECIMEN - LOADING METHOD

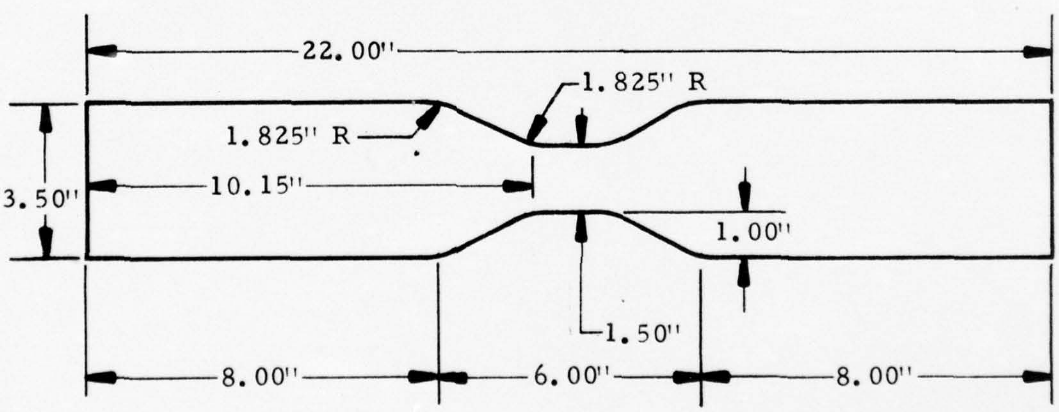


FIGURE 28B FLEXURAL BEAM SPECIMEN - CONFIGURATION

a two ply doubler as shown in Figure 3 . In order to insure that the beam would fail in flexure the core was removed and replaced with potting up to a point 0.5 inch inside of the load concentrations.

The twelve tensile specimens consisted of six (6) upper skin coupons and six (6) lower skin coupons with the core removed. They were fashioned for testing as shown in Figure 29.

The results of tests on the manufacturing development article are shown in Table XVI.

TABLE XVI - TEST DATA-MANUFACTURING DEVELOPMENT SPECIMEN

SPECIMEN		REMARKS
Flex Specimens	Load	
B	780#	Failed in necked down area
A	1065#	Failed in necked down area
C	3970#	Failed at edge of doubler outboard of outboard hinge
Inserts	Load	All values except compression 3 were to 115%
Tension-1,2,3	221#	No failure
Compression-1,2	771#	No failure
Compression 3	1805#	Failure
Torque 1,2,3	70 in-lb	No failure
Tensile	F_{tu}	Loads shown are averages
A	105,330	0°, w/o screen bonded tab failure
B	88,870	0°, w screen; failed center (test section)
C	13,670	90°, w/o screen; failed edge of bonded grip end
D	11,930	90°, w screen; failed edge of bonded grip end

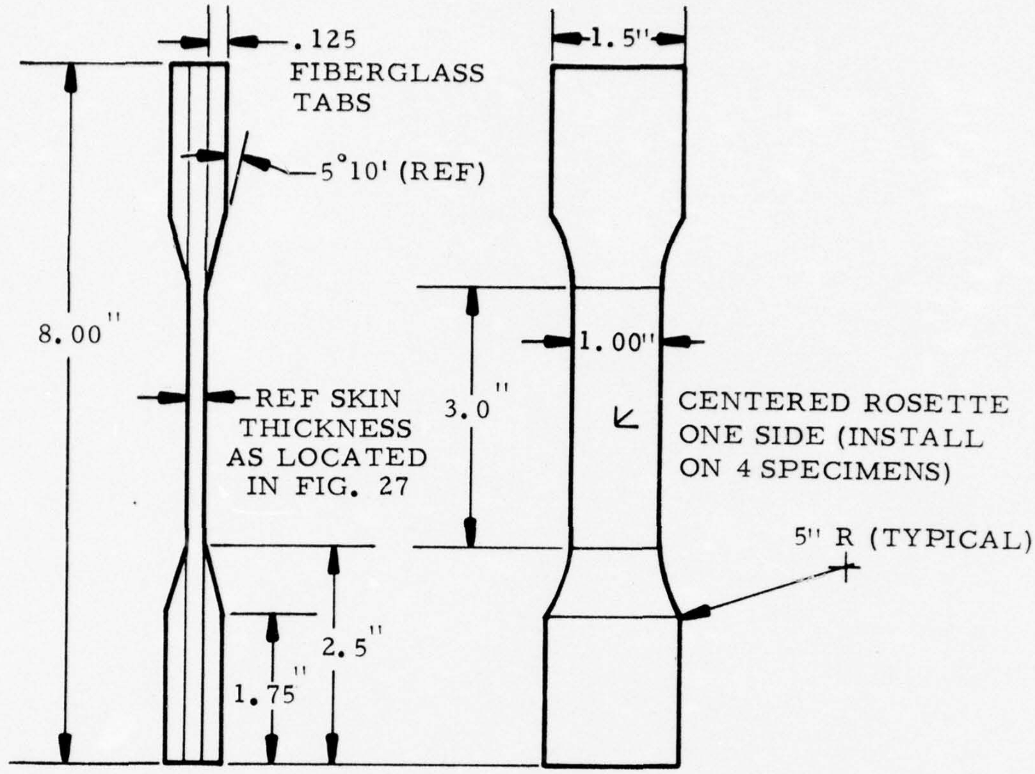


FIGURE 29 TENSILE COUPONS - MANUFACTURING DEVELOPMENT SPOILER

As can be seen in Figure 27 one of the flex specimens was cut across the outboard hinge area and included four inserts. This specimen had a 10 ply upper and an 8 ply lower surface. The other two flex specimens had 6 ply upper and lower surfaces. The specimen with the inserts failed along the edge of doubler on the outboard side. The other two failed in the necked down section, at the edge of the radius.

The inserts were tested to 115% of design limit load as verification of predicted strength. One of the compression specimens was tested to failure to get an idea of actual strength and margin of safety. It tested to 1805 lbs or 270% of design limit load.

There is an aluminum screen used for lightning strike protection on one side of the spoiler. Therefore, half of the tensile specimens were tested with a screen and half without. The screen, as shown by tests on the process control specimens, had a weakening effect on the specimens.

Four spoiler assemblies were fabricated for testing at NADC. The first three articles are for static testing while the fourth is a fatigue article. Static test articles 1 and 2 were fabricated in the same manner as the manufacturing development article. Static article 3 and the fatigue article were manufactured in accordance with the revised manufacturing plan as described in Appendix C. The change allows direct layup of the edge doublers, deleting the use of doubler transfer templates.

The glass epoxy molding tool has the edge of part (EOP) outline and two tooling hole locations scribed lightly on the OML surface. Two removable tooling pins were utilized to key all mylar templates to the EOP outline. Figure 30 shows the molding tool with tooling pins attached by double faced tape. To provide a surface for lay-up of the skins for the spoiler an outline of the spoiler, which includes .38 trim on all sides, was drawn on a polyethylene sheet. This surface shown in Figure 31 also included a table of ply numbers and orientations. A sheet of nylon film was taped to the table and the lower skin was hand layed-up ply on ply. Ply Number 1 is shown in Figure 32. Figure 33 shows partial completion of ply number 6. Partial plies Numbers 7 and 8 are shown in Figure 34. The complete, template trimmed lower skin is shown in Figure 35. A single sheet of 45° orientation broad goods was prepared. Metal templates were used to trim the picture frame doublers to size. The lower skin and doubler plies were transferred to the tool by utilizing mylar transfer templates. Figure 36 shows doubler ply number 14 on the transfer template. The complete lower skin/picture frame subassembly, after vacuum debulking is shown in Figure 37.

Film adhesive is applied to the lower surface of the previously machined and cleaned honeycomb core segments. Foam adhesive is applied to the ends of the center core segment. Starting with one of the end segments the core is applied to the skin/doubler subassembly. This stage of manufacture is shown in Figure 38. Film adhesive is now attached to the upper and sloped edges of the core. The protective film is left in place during the lay-up and trim of the upper skin assembly. This lay-up process is accomplished in a similar manner to that employed in the fabrication of the lower skin. Transfer to the tool is again accomplished by transfer template. The upper skin requires draping and trimming at each corner. Vacuum debulking is again used after the upper skin application as shown in Figure 39.

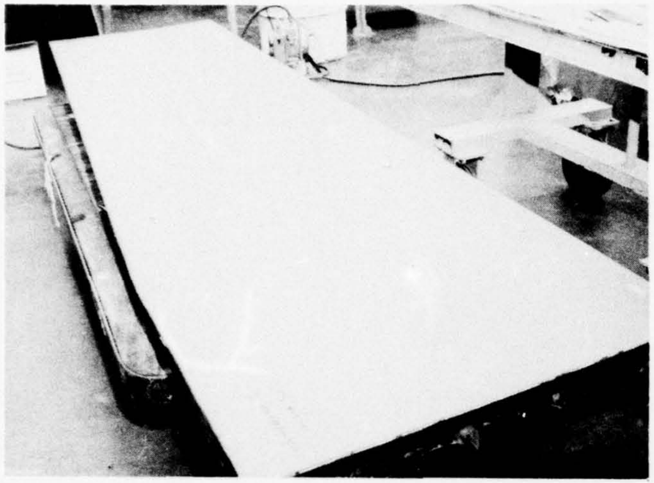


FIGURE 30: GLASS/EPOXY SPOILER MOLDING TOOL

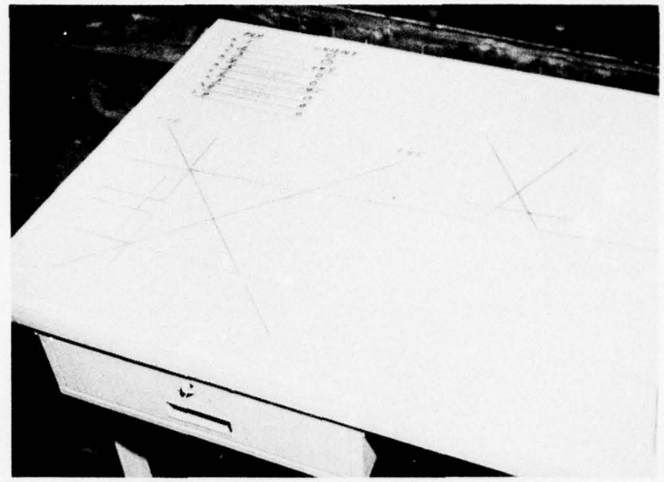


FIGURE 31: SKIN LAY-UP GUIDE

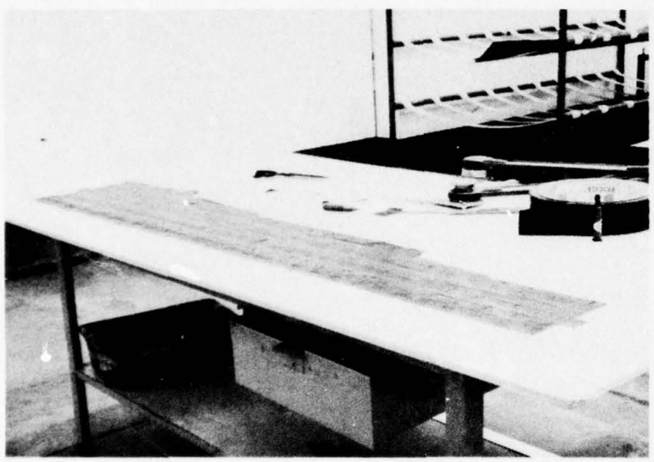


FIGURE 32: LOWER SKIN PLY NO. 1

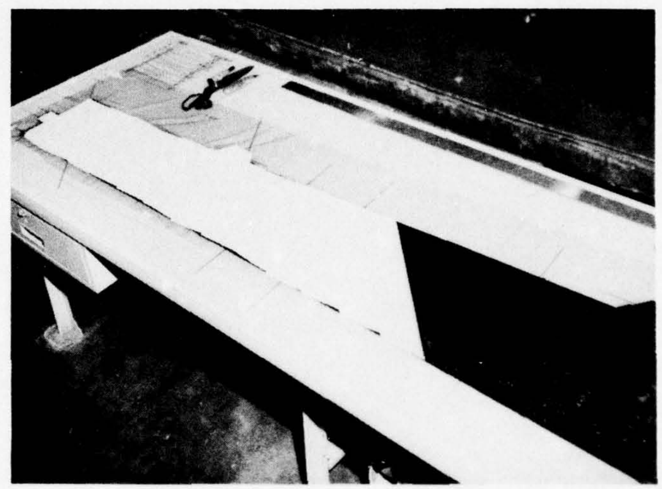


FIGURE 33: LOWER SKIN, LAY-UP OF PLY NO. 6

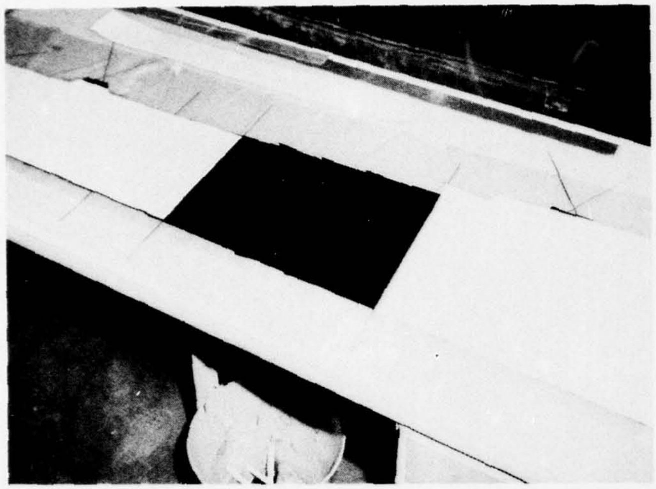


FIGURE 34: LOWER SKIN, PLIES NO. 7 AND 8

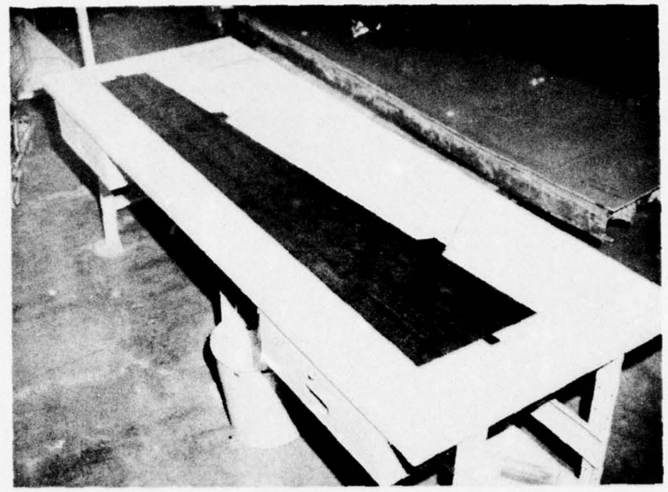


FIGURE 35: LOWER SKIN, LAY-UP COMPLETE, TEMPLATE TRIMMED

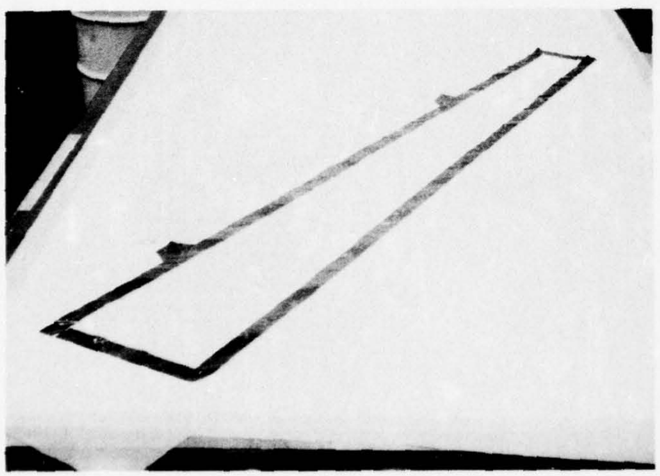


FIGURE 36: PICTURE FRAME DOUBLER, PLY 14, ON TRANSFER TEMPLATE

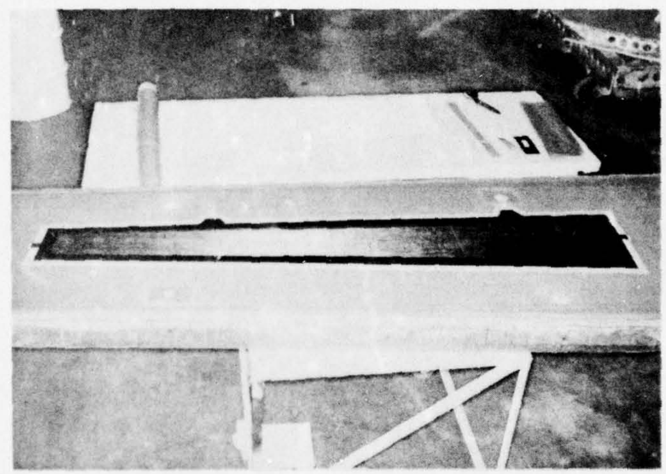


FIGURE 37: LOWER SKIN AND PICTURE FRAME DOUBLERS AFTER TRANSFER TO MOLDING TOOL

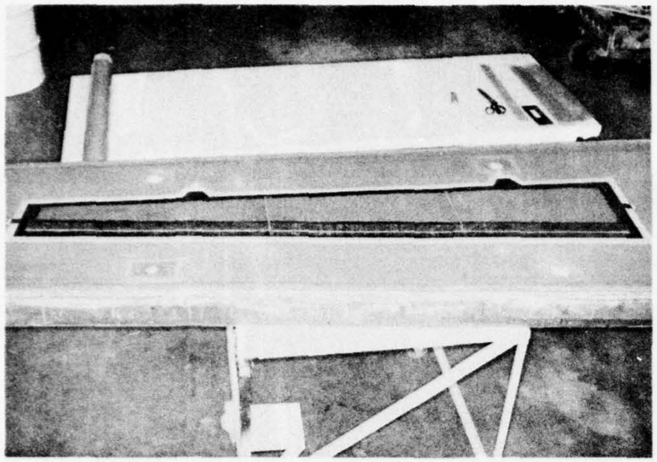


FIGURE 38: MACHINED CORE SEGMENTS APPLIED TO LOWER SKIN ASSEMBLY

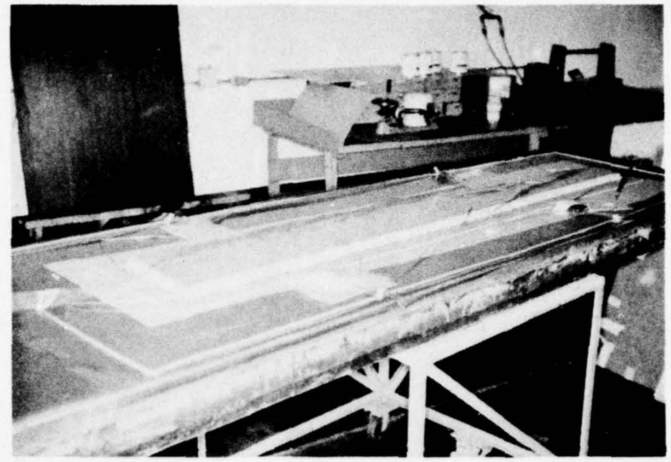


FIGURE 39: VACUUM DEBULKING OF SPOILER ASSEMBLY

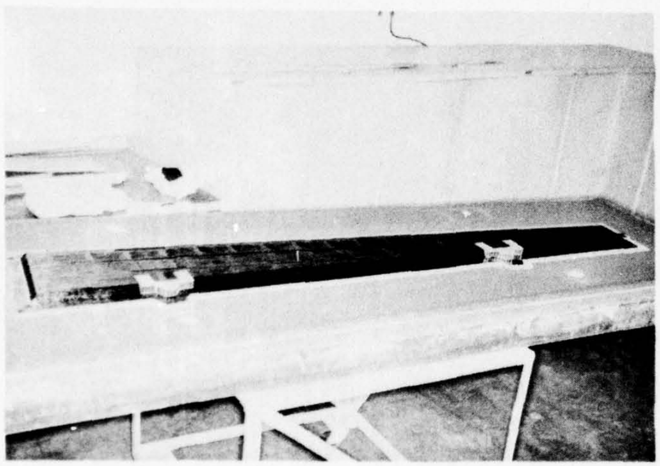


FIGURE 40: SPOILER ASSEMBLY, DEBULKING COMPLETE, TAB STIFFENERS INSTALLED

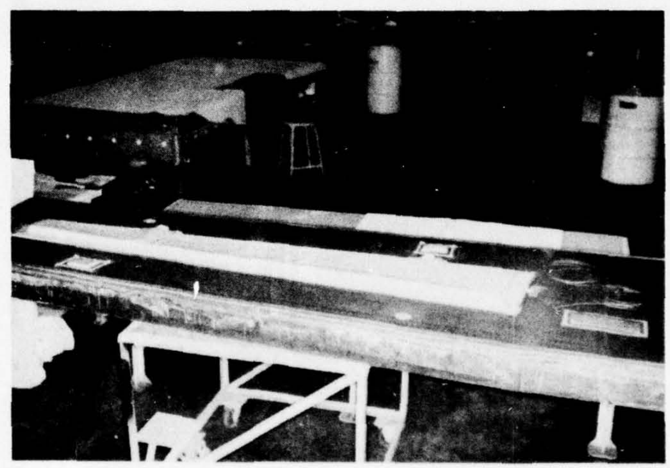


FIGURE 41: BAGGING PREPARATION, BLEEDER PLY INSTALLATION

The precured tab stiffeners are template located on the spoiler assembly, after application of film adhesive to the core to spoiler faying surface. Figure 40 shows these tab stiffeners in place, as well as the Corprene dam in place around the spoiler. Peel ply, teflon coated glass fabric, and resin bleeder material, as shown in Figure 41, are secured to the part.

Two process control specimens are required, per specification 208-8-3. P/C 1 is a sixteen ply unidirectional laminate, from which flexure and short beam specimens are made. Both P/C 1 and P/C 2 are shown in Figure 42. P/C 2 is a sandwich specimen with seven ply alternate 0° and 90° oriented skins. Flatwise tensile specimens are fabricated from this sandwich. Both specimens are cured under the vacuum blanket covering the spoiler assembly.

Figures 43 and 44 show the caul plate and pressure block installation prior to bagging. The caul plates are 0.020 aluminum alloy. The 30° sloping surface of the spoiler utilizes two angles with a 0.008 slip sheet under the angles at the joints. The pressure blocks are wooden strips which fit the caul angles on two sides and slope upward from the tool surface.

Figure 45 shows the tool, spoiler assembly and process control specimens after the completion of the bagging operation, but prior to cure. Four thermo couples were employed during the cure of each spoiler assembly. A thermocouple is located in each of the tooling tabs. While one is located in the solid laminate process control specimen, the other is located in the lower skin of the sandwich process control specimen.

Figures 46 and 47 show the upper and lower surfaces of static article Number 1. Close-up views of the hinge installation and tab stiffner sealant application is depicted in Figures 48 and 49.

Views of the upper and lower surfaces of static articles 2 and 3 and the fatigue article are shown in Figures 50 thru 55.

To verify spoiler final assembly one of the spoilers was attached to a S-3A wing assembly. The actuation system was operated and no signs of unusual operation or system malfunction was noted. Figures 56 and 57 show this installation.

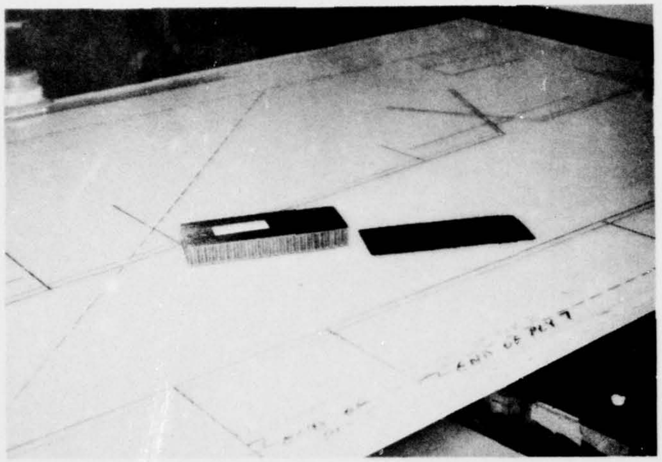


FIGURE 42: PROCESS CONTROL SPECIMENS

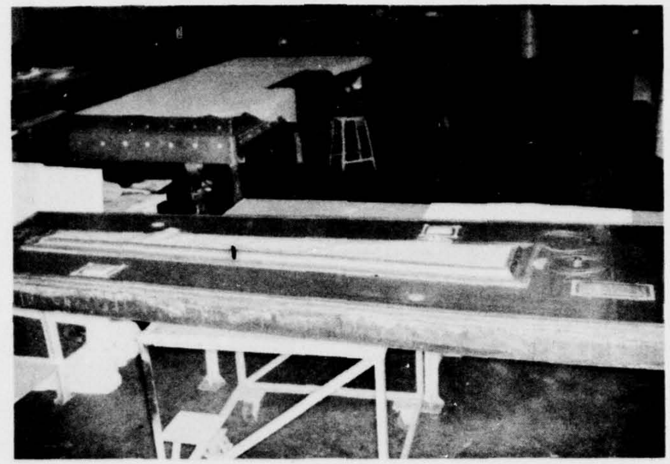


FIGURE 43: BAGGING PREPARATION, PARTIAL CAUL PLATE INSTALLATION

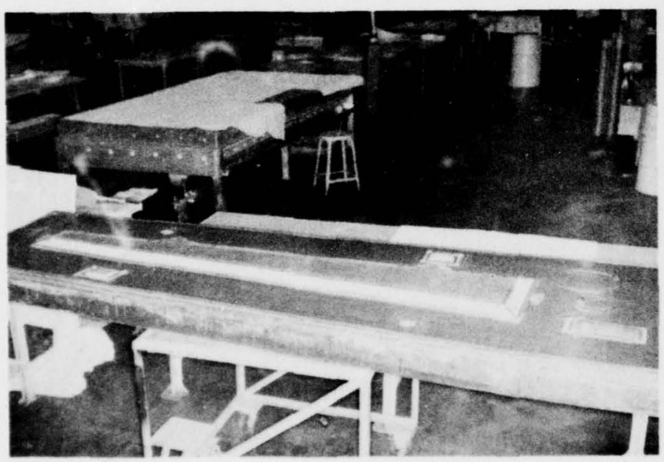


FIGURE 44: BAGGING PREPARATION, PRESSURE BLOCKS INSTALLED

FIGURE 45: BAGGED PART AND SPECIMENS, READY FOR CURE

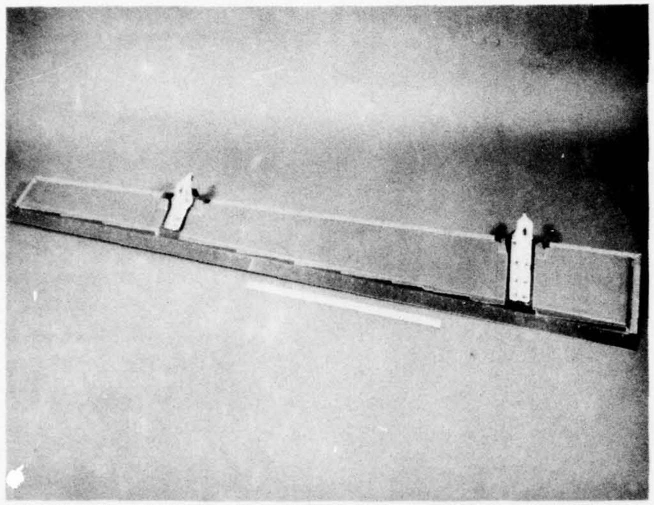


FIGURE 46: UPPER SURFACE, STATIC ARTICLE NO. 1, SPOILER ASSEMBLY

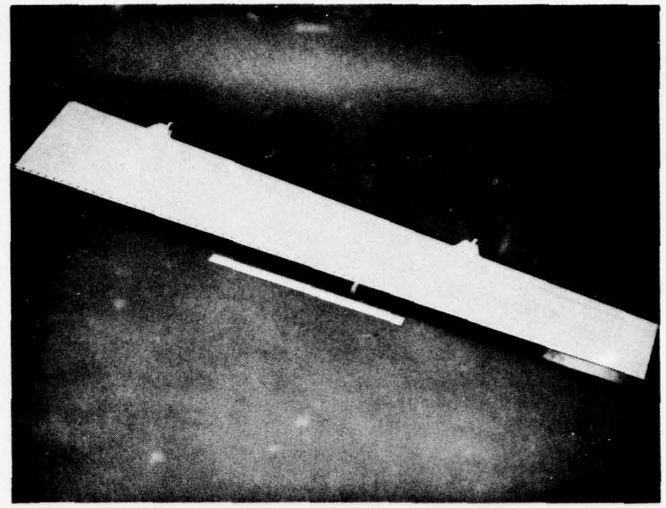


FIGURE 47: LOWER SURFACE, STATIC ARTICLE NO. 1 SPOILER ASSEMBLY

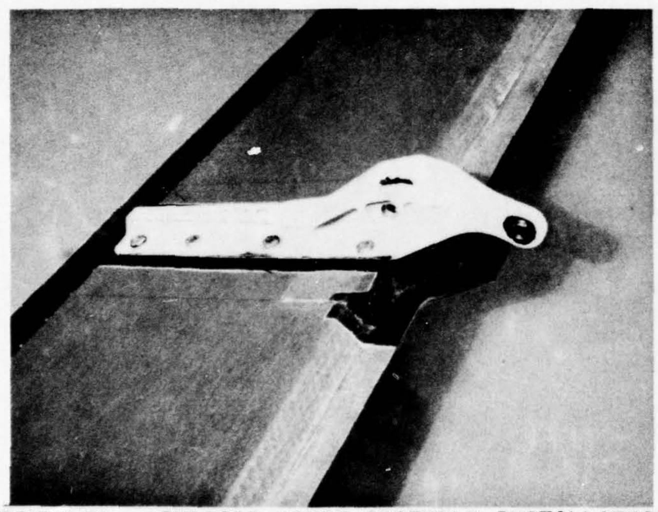


FIGURE 48: INBOARD HINGE ASSEMBLY INSTALLATION,

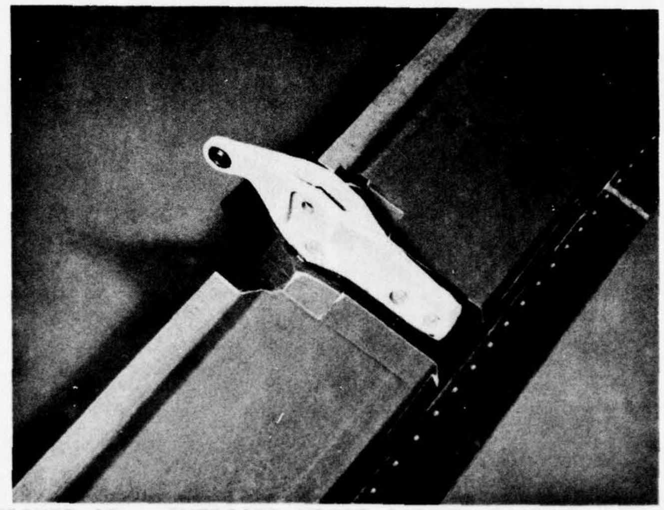


FIGURE 49: OUTBOARD HINGE ASSEMBLY INSTALLATION

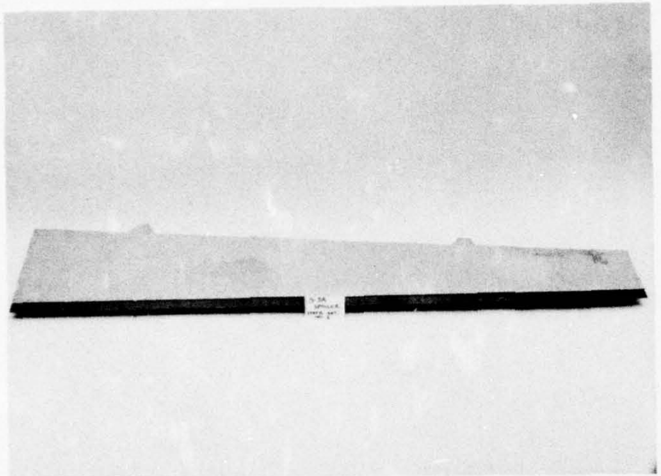


FIGURE 50: LOWER SURFACE, STATIC ARTICLE NO. 2, SPOILER ASSEMBLY

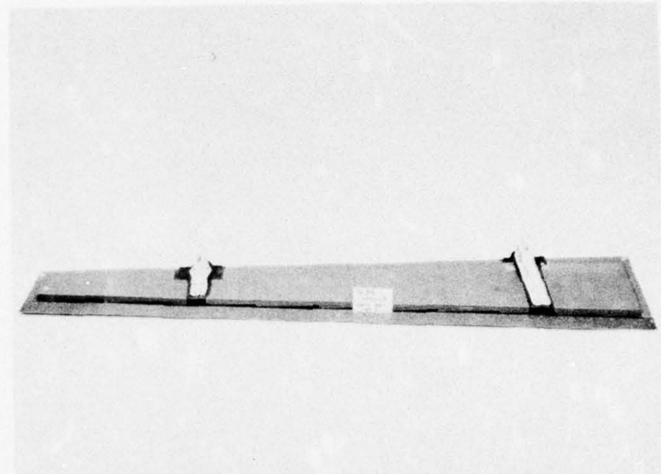


FIGURE 51: UPPER SURFACE, STATIC ARTICLE NO. 2, SPOILER ASSEMBLY

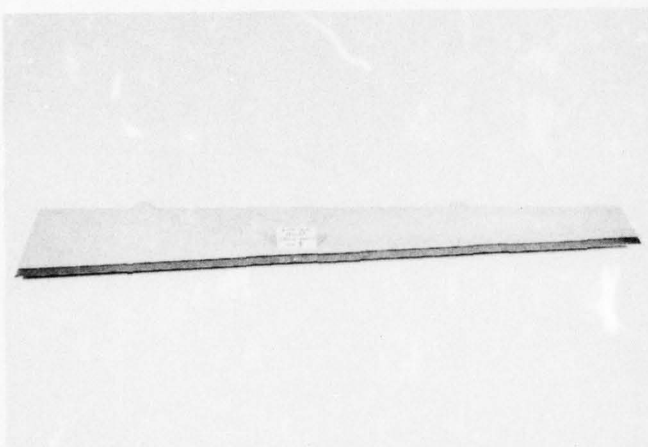


FIGURE 52: LOWER SURFACE, STATIC ARTICLE NO. 3, SPOILER ASSEMBLY

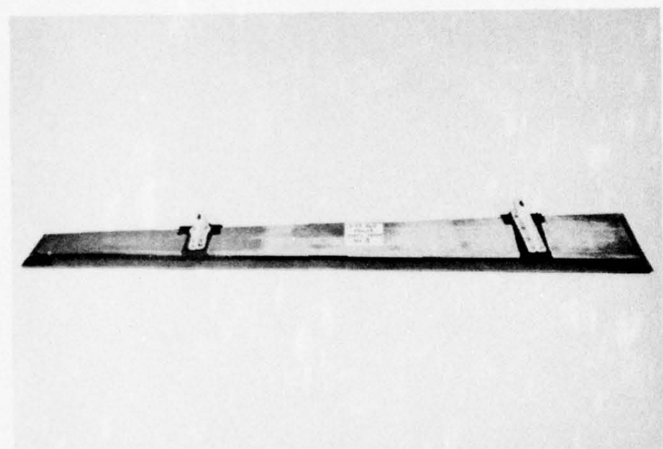


FIGURE 53: UPPER SURFACE, STATIC TEST ARTICLE NO. 3, SPOILER ASSEMBLY

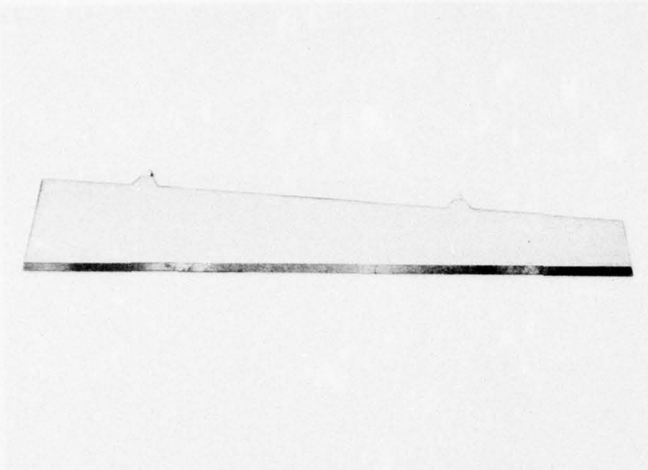


FIGURE 54: LOWER SURFACE, FATIGUE ARTICLE, SPOILER ASSEMBLY

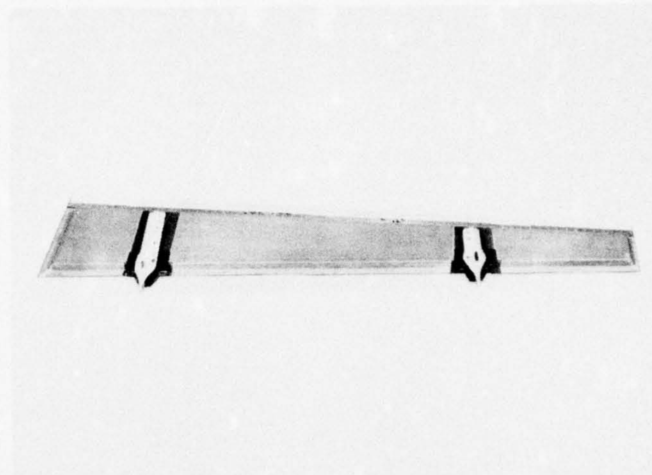


FIGURE 55: UPPER SURFACE, FATIGUE ARTICLE, SPOILER ASSEMBLY

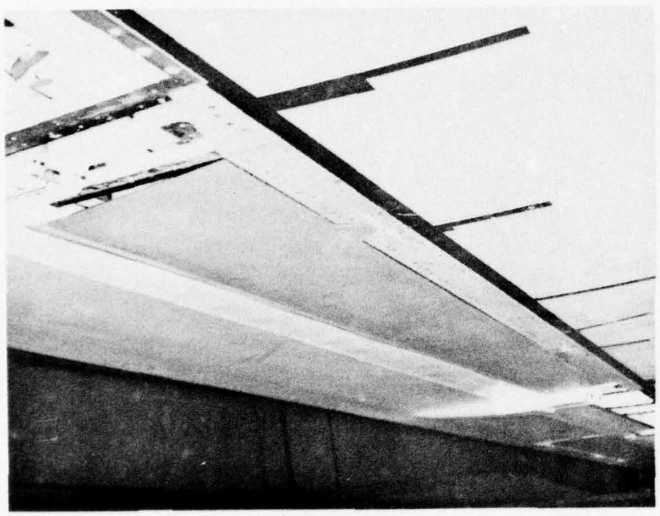


FIGURE 56: GRAPHITE/EPOXY SPOILER INSTALLED ON S-3A WING, CLOSED POSITION

FIGURE 57: GRAPHITE/EPOXY SPOILER INSTALLED ON S-3A WING, EXTENDED POSITION

During the fabrication of static article Number 3 and the fatigue article the fabrication sequence was altered slightly to eliminate the usage of the picture frame doubler transfer templates for assembly. This change reduced the man hour requirements for spoiler fabrication. This change is reflected in the Revised Manufacturing Plan as shown in Appendix C.

SECTION 4

COMPONENT TESTING

All of the component testing was conducted by the Naval Air Development Center at Warminster, Pennsylvania under the direction of Mr. A. Manno. Test results and data were supplied to VSD for incorporation into this report. The full scale component tests conducted under the contract include three static tests and a fatigue test as defined in the test plans. The static test plan, report number 2-53440/3R-10108 included in Appendix B defines test loads and conditions. The fatigue test plan, report number 2-53440/3R-10109 is also included in Appendix B.

Two types of process control specimens were fabricated per process specifications during each spoiler assembly cure. One specimen consisted of a 16 ply unidirectional solid laminate which was cut into three zero degree flexure and three shear specimens for testing. The second specimen was a honeycomb sandwich panel with the same core as the spoiler and seven ply skins oriented 0, 90, 0, 90, 0, 90, 0. This was cut into three 2" x 2", flatwise tensile specimens. The test results on these specimens are compared to the manufacturing development components control specimens in Table XVII, and indicate no deficiencies in manufacturing process control. Table XVIII gives the actual weight versus the predicted weight of the finished test components.

The static test articles were loaded as defined in the Static Test Plan shown in Appendix B, and evaluated for strength and stiffness, to verify the design capability of the spoilers. Stresses and deflections were measured by five rosette gauges and twelve deflectometers on each spoiler.

Although the closing condition is the critical condition, the opening condition was tested to substantiate the spoiler performance for tension loads in the areas of the hinges. Each test checked three data points for the closing condition (150% DLL, 177% DLL, and failure), and one data point for the opening condition. The requirement for sustaining 177% of DLL as a check point in testing resulted from an S-3A operational change which deactivates the upper outer spoilers and increases the loading on the remaining spoilers.

TABLE XVII - PROCESS CONTROL TEST RESULTS

ARTICLE	FLATWISE TENSION	FLEXURE	MODULUS 10^6	SHORT BEAM SHEAR
Static No. 1	1070*	258,923	18.60	13,065
Static No. 2	958	215,780	17.47	13,787
Static No. 3	1022	230,961	18.10	13,501
Fatigue Article	892	234,166	20.04	14,121
M. D. Article	1061	231,469	18.03	13,366

* All Values Average

TABLE XVIII - ACTUAL SPOILER WEIGHT VS. PREDICTED WEIGHT

ELEMENT	PREDICTED WEIGHT	ACTUAL WEIGHT			
		STATIC NO. 1	STATIC NO. 2	STATIC NO. 3	FATIGUE
Spoiler	8.40	8.31	8.34	____**	____**
Spoiler* With Fittings	12.28	11.59	11.65	12.09	12.05

* Fittings Include Hinges, Seals, Hardware

** Not Weighed

STATIC TESTS

As required per contract, three static test articles were fabricated according to the drawings of Appendix A, and the materials and process specifications of Table IV. These components were shipped to NADC where the actual testing was accomplished.

Static Test - Spoiler #1

The test report for static spoiler number 1 is presented in Appendix B. The spoiler was loaded thru the test sequence shown in Table XIX.

TABLE XIX - STATIC TEST #1 RUN SEQUENCE

RUN NUMBER	CONDITION	MAX LOAD (% DLL)	REMARKS
1	Opening	40	Check loading fixture
1a	Closing	40	Check loading fixture
2	Opening	100	
3	Opening	115	
4	Closing	100	
5	Closing	150	
6	Closing	177	
7	Closing	230	
7a	Closing	290	Failure at 300% DLL before gages could be read

The critical strains and deflections were checked after each run and showed acceptable correlation with the predicted values. The deflection at the outboard tip was less than that of the metal spoiler at the same load. Loading was applied in increments until failure. Failure occurred suddenly at 300 percent DLL, at the edge of the outboard doubler. There were no preliminary audible indications of failure.

Strain measured at the gauge located nearest to the point of failure, when extrapolated to the point of failure, was .00430. Using this value in the

point stress analysis routine, discussed in Section 2, results in close agreement with test results at 300% DLL. The calculated failure occurred at the same point as on the flexural beam specimen cut from the manufacturing development article. When the measured strain was extrapolated to the area of the outboard hinge, the strain was .0061. This value, being higher than predicted by previous tests (TR-141, Table X), indicates that local load redistribution because of the hinge pad reduces the local stress.

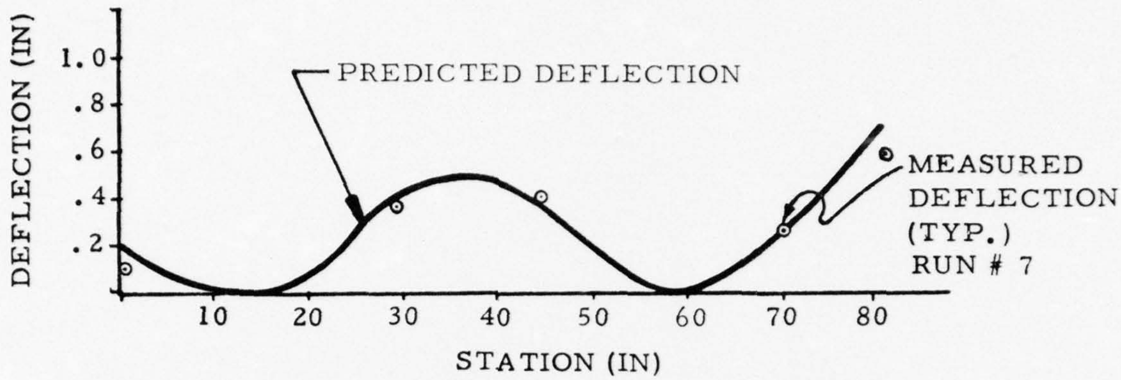
Measured deflections show close agreement with the predicted values, and are within 10% of the predicted values at 150% DLL. A comparison of measured and predicted leading edge and trailing edge deflections for Static Test Article number one (1) are shown in Figure 58.

Static Test - Spoiler #2

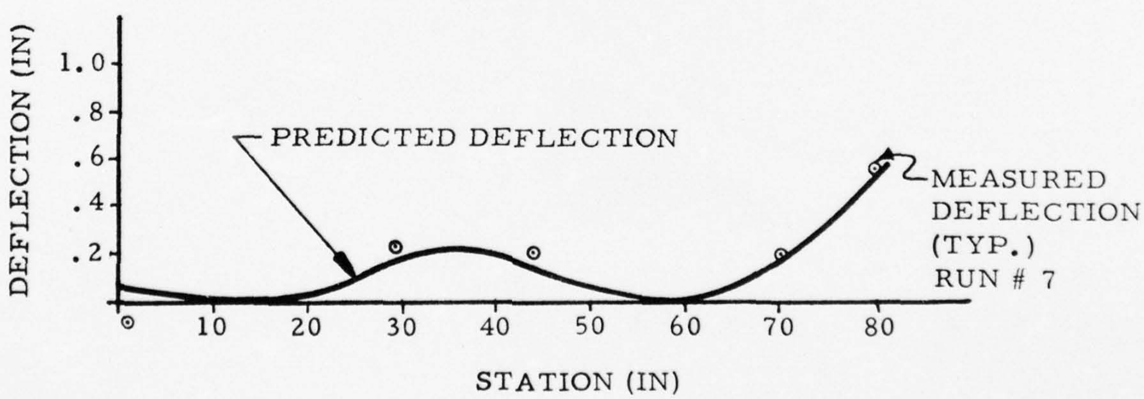
The test report for static spoiler number 2 is presented in Appendix B. The second test series is given in Table XX.

TABLE XX - STATIC TEST #2-RUN SEQUENCE

RUN NUMBER	CONDITION	MAX LOAD (% DLL)	REMARKS
1	Opening	40	Check run
2	Opening	115	
3	Opening	150	
4	Closing	40	Check run
4a	Closing	40	Check run
5	Closing	100	
5a	Closing	100	Check run
6	Closing	150	
7	Closing	177	Lost tension pads (reworked)
7a	Closing	80	Discontinued due to pad unbonding
7b	Closing	177	Retest run #7
8	Closing	240	
9	Closing	350	Failure at 360% DLL before gages were read.



LEADING EDGE



TRAILING EDGE

FIGURE 58 MEASURED VERSUS PREDICTED DEFLECTIONS STATIC TEST # 1 AT 150% DLL

Failure on this spoiler occurred at the same location as in the first spoiler test. All data and measurements taken indicate similarity to test data taken during test number 1. The leading and trailing edge deflected shapes are plotted and compared to the predicted shapes for 150% DLL as shown in Figure 59.

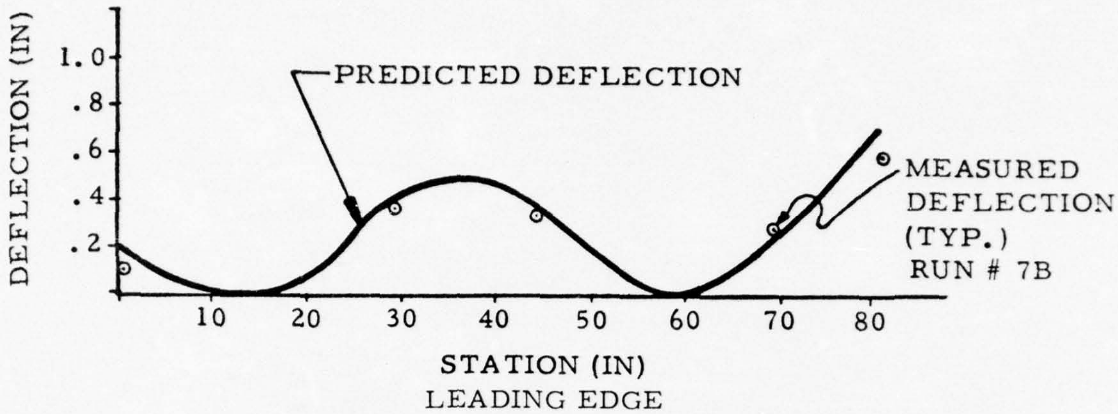
Static Test - Spoiler #3

The test report for static spoiler number 3 is presented in Appendix B. The run sequence for this test is given in Table XXI.

TABLE XXI - STATIC TEST #3 - RUN SEQUENCE

RUN NUMBER	CONDITION	MAX LOAD (% DLL)	REMARKS
1	Opening	40	Check run
2	Opening	115	
3	Opening	150	
4	Closing	40	Check run
5	Closing	100	
6	Closing	150	
7	Closing	177	
8	Closing	160	Lost pads (reworked)
8a	Closing	100	recalibration check
8b	Closing	240	
9	Closing	340	Lost pad - test fixture problems
9a	Closing	160	Test fixture problem
9b	Closing	260	Lost pad (reworked)
9c	Closing	370	Failed at 375% DLL while loading

Failure on the third spoiler occurred in approximately the same location as the first and second spoilers. The recorded data was showing the same similarity as achieved in prior tests. The leading and trailing edge deflected shapes for spoiler number 3 are plotted and compared to predicted shapes for 150% DLL in Figure 60.



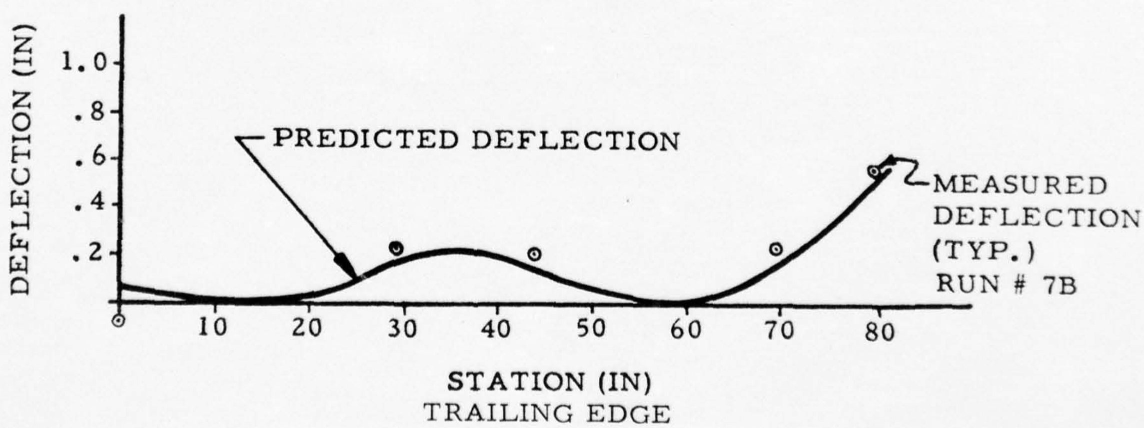
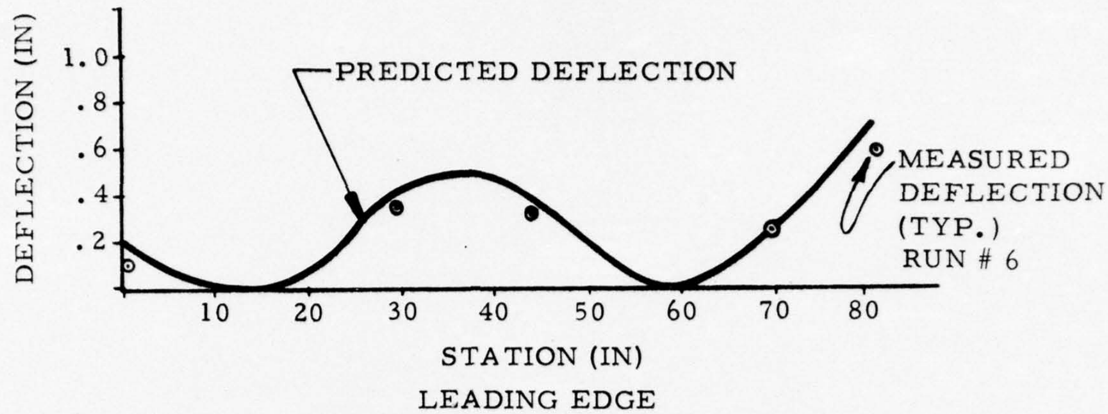


FIGURE 59 MEASURED VERSUS PREDICTED DEFLECTIONS - STATIC TEST #2 AT 150% DLL



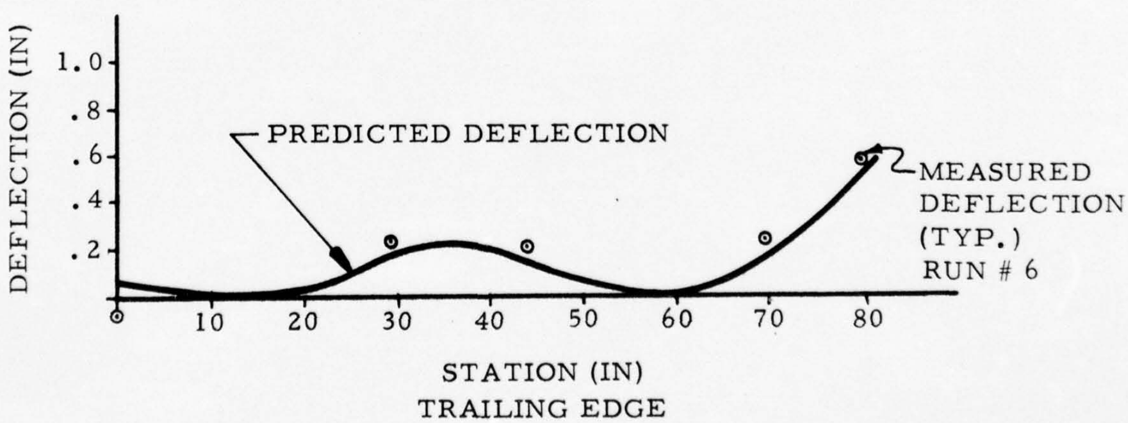


FIGURE 60 MEASURED VERSUS PREDICTED DEFLECTIONS - STATIC TEST #3 AT 150% DLL

FATIGUE TEST

One fatigue test article was fabricated in the same manner as the preceeding static test components and delivered to NADC for life testing. After successful completion of the required cyclic testing as defined in the test plan additional testing was performed. Table XXII shows the test sequence used. The fatigue test report is presented in Appendix B.

TABLE XXII FATIGUE TEST-RUN SEQUENCE

CONDITION	OPENING LOAD	CLOSING LOAD	LIFETIMES	REMARKS
FATIGUE SPECTRUM	SEE FATIGUE TEST PLAN IN APPENDIX B	SEE FATIGUE TEST PLAN IN APPENDIX B	2	NO DAMAGE
FATIGUE SPECTRUM	150% DLL	177% DLL	2	REPLACED SOME METAL PARTS
STATIC TEST	—	330% DLL	—	FAILURE

The critical strains and deflections were monitored during the fatigue design requirements test and no significant changes were observed. Upon the completion of the fatigue design requirements tests, the test loads were modified to 150% DLL for opening loads and 177% DLL for closing loads and the fatigue test rerun. Damage did occur to both the graphite and metal parts during this modified testing. Details of the damage incurred are in the Fatigue Test Results Report in Appendix B.

After completing the fatigue tests, a static test to failure was accomplished. Failure occurred at 330% DLL; the fracture was similar to the previous static tests. The location of the failure was approximately four inches outboard of the outboard hinge fitting. There was no audible warning prior to failure.

SECTION 5
COST COMPARISONS

INTRODUCTION

Graphite epoxy material is a new material with desirable engineering characteristics for aerospace design. However, a new material not only must have the desired engineering properties, but also must be cost competitive or have lower cost when comparing components fabricated with the new material to metallic components. One of the objectives of this contract was to demonstrate that a graphite epoxy spoiler could be fabricated for lower cost than the semi-monocoque metal spoiler for the production quantity planned. The ground rules by which the cost comparison data was collected are as follows:

- The graphite epoxy spoiler assembly is interchangeable with the aluminum alloy spoiler assembly - physically and characteristically. The graphite epoxy spoiler can replace a metal spoiler on the airplane without any modification to the aircraft.
- The hinges for the graphite spoiler are identical to the hinges on the metal spoiler except the attaching bolt holes will be a larger diameter.
- The cost comparison between the graphite epoxy spoiler and metal spoiler will use the S3A production lots, rates and quantities. Thus, the metal spoiler will be "actuals" for the quantity produced through 1 July 1974 and will insure identical production program.
- The cost comparison will use constant dollars. The direct labor rates and overheads will be constant during the production period as will the cost of material.
- The direct labor rates and overheads are calendar 1975 averages as negotiated with Naval Plant Representative Office, Dallas, Texas.
- The average cost curve for the sheet metal spoiler is based upon the actual cost of the first 53 ship sets of spoiler produced by 1 July 1974. The costs were obtained from VSD's standard cost tracking system. The cost for the remaining spoilers to the 200 unit is predicated from the progress curve determined from these first 53 sets.
- The cost for the graphite epoxy spoiler will be an estimate for 200 production articles. The estimate was made after the five developmental spoilers had been produced.

COST MONITORING SYSTEM

Standard Cost Monitoring

The cost monitoring system at VSD is designed to fulfill the reporting requirement for Cost Schedule Control Systems Criteria (CSCS). Under this system, the tasks are divided into contractual line items which have cost reporting functions and a Work Breakdown Structure (WBS) per MIL-STD-881. The WBS is further broken down to 5th and 6th levels to provide VSD with details for adequate control. The cost monitoring system which accumulates the desired cost is an Alpha-Numeric code which identifies the contract and WBS level. In addition, each departmental function such as engineering, tooling, materials, manufacturing and quality is identified for each WBS element. The functional cost can be identified for any WBS item which has been coded.

Sheet Metal Spoiler Costs

The sheet metal spoiler is fabricated under a WBS code. The code is for a ship set of spoilers and contains the contract number, line item and departmental functional notation. The charges by departmental elements have been accumulated for fifty-three ship sets of metal spoilers completed by 1 July 1974. The cost for the metal spoiler which is being replaced by the composite spoiler has been estimated by the responsible departments (Manufacturing Controls - Factory, Materials for direct materials, etc.) from the actual data accumulated by WBS code.

The techniques employed by each department are varied, but historically have produced consistent results; therefore, the cost for the metal spoiler is a "best cost estimate" possible from actual data of multiple spoiler components. The estimates were then dollarized in constant 1975 dollars and used to develop the curve in Figure 61.

Sheet Metal Spoiler Cost Drivers

The cost contributors for the sheet metal spoilers are factory labor, raw materials, quality assurance, sustaining tooling, and sustaining engineering. Figure 62 indicates the percentage for each of these elements as a function of quantity of articles. As noted, the primary cost driver is factory labor with raw materials a strong second. Analysis of data shown in Figure 62 indicates that an increase in material cost requires a large decrease in factory labor to maintain cost competitiveness. The cost for the composite

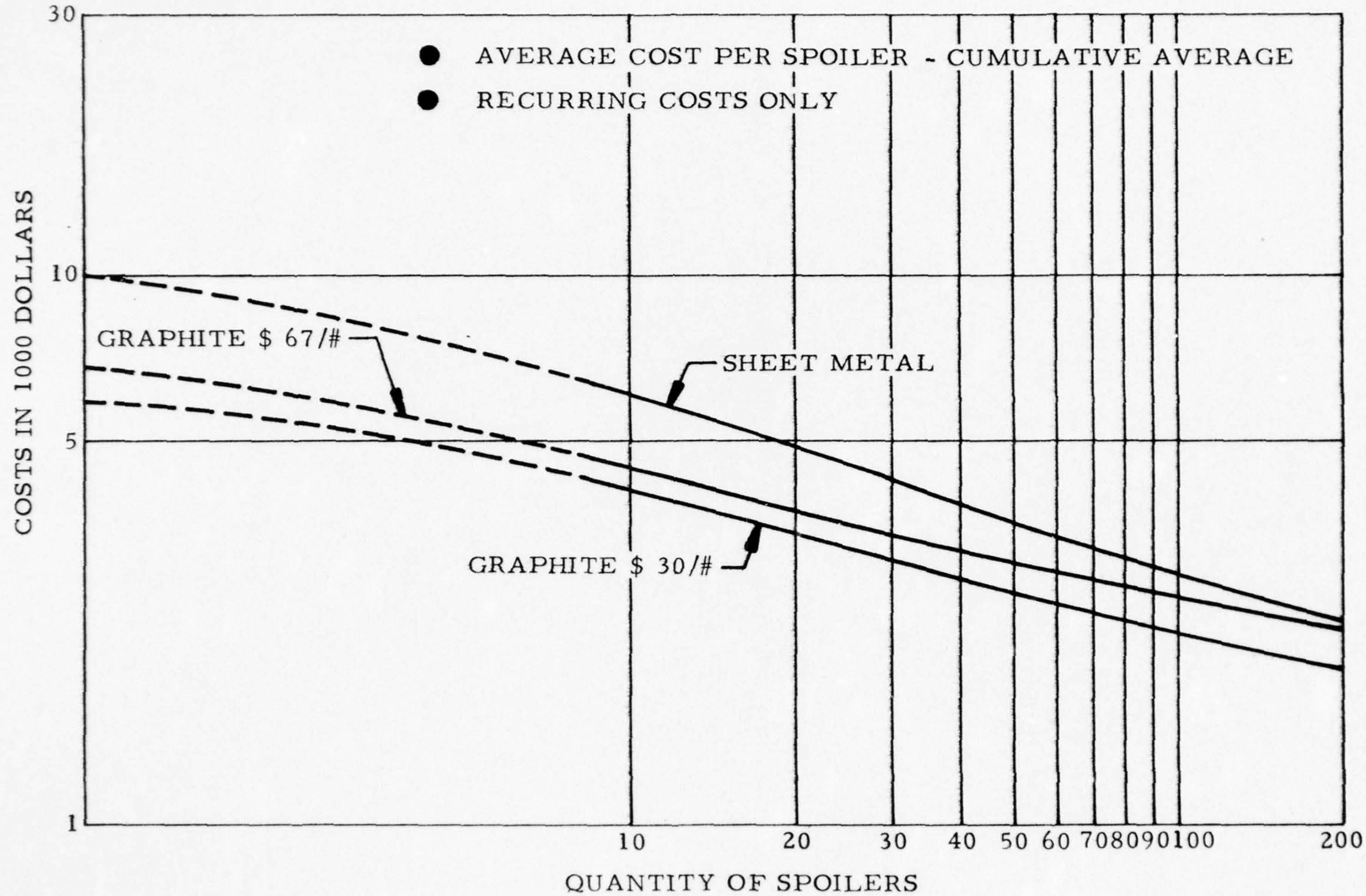


FIGURE 61 COST COMPARISON - METAL VERSUS GRAPHITE / EPOXY SPOILER

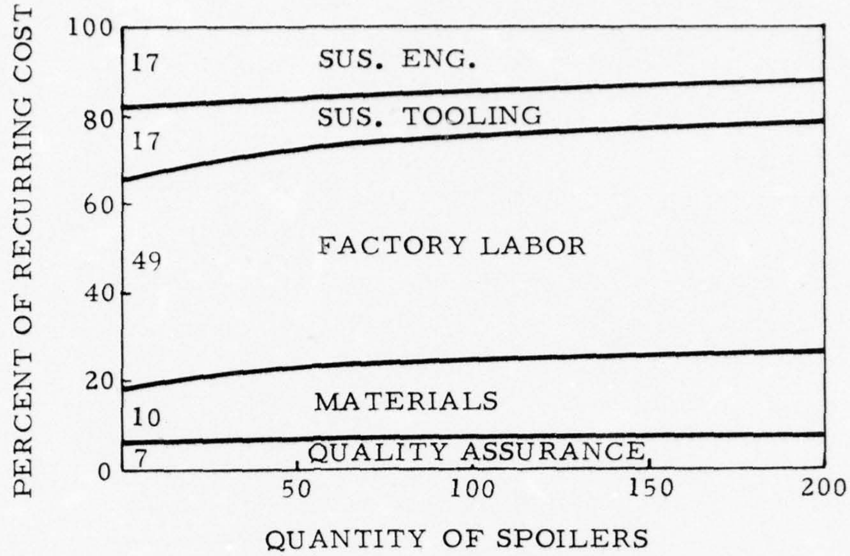


FIGURE 62 PERCENTAGE OF RECURRING COST FOR FUNCTIONAL ELEMENTS - SHEET METAL SPOILERS

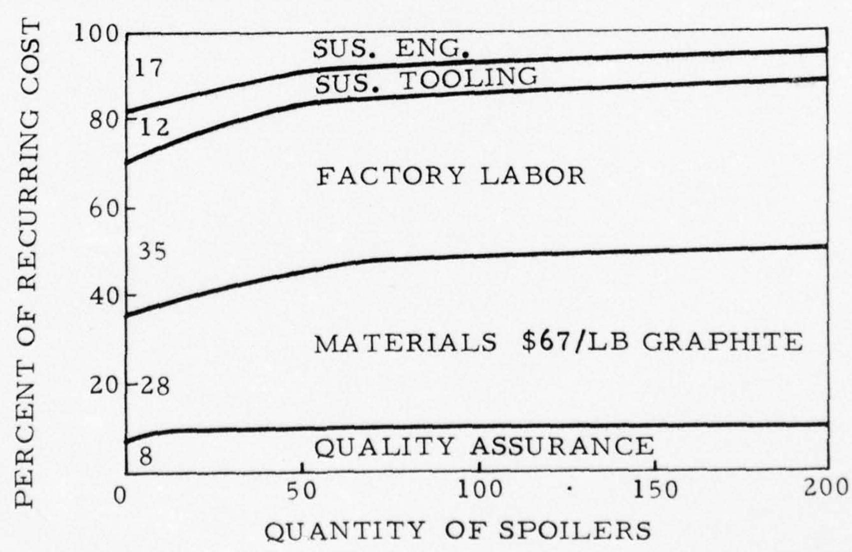


FIGURE 63 PERCENTAGE OF RECURRING COST FOR FUNCTIONAL ELEMENTS - COMPOSITE SPOILER

spoiler reflects a decrease in factory labor, an increase in raw material cost, and shows this spoiler to be cost competitive with the sheet metal spoiler.

Composite Spoiler Costs

The costs for the composite spoiler were estimated after the five developmental spoilers were fabricated. The first five spoilers were used to develop and qualify the process as well as gain some production experience. The departmental estimates were dollarized in constant 1975 dollars and the recurring cost for 200 spoilers is shown in Figure 61.

The cost for the graphite epoxy material for the basic estimate was $67 per pound. A separate cost estimate was made using an estimate of $30 per pound for graphite epoxy. This estimate is also shown for reference on Figure 61.

Composite Spoiler Cost Drivers

The cost contributors for the composite spoilers are factory labor, raw materials, quality assurance, sustaining tooling, and sustaining engineering. Figure 63 illustrates the percentages for each of these elements as a function of the quantity of articles. Factory labor is the primary cost driver in the beginning but is replaced by raw materials as the quantity increases. The reason for the reversal of the roles is the progress curve for labor is steeper (faster rate) than the progress curve for materials. The high cost of graphite raw material requires a savings in manhours to offset the material cost delta. Quality requirements for graphite/epoxy structures is more than metal structure for the reasons shown: (1) additional receiving inspection to insure raw material compliance to specification, (2) revalidation testing after 90 days to prolong material shelf life, and (3) the additional quality requirements for bonded structure. With additional experience, the cost for quality assurance will decrease in percentage and approach the requirements of the metallic structure.

COST COMPARISONS GRAPHITE/EPOXY-METAL

Production Program Cost Comparison

The cumulative average cost for the functional elements which comprise the total recurring costs are compared at quantities of 8, 101, and 200 units in Table XXIII. Costs of the sheet metal spoilers are projected from the first 53 ship sets costs and the graphite spoiler costs are projected from the five articles fabricated for this study.

TABLE XXIII- FORMAT FOR COST REPORTING-METAL VERSUS COMPOSITE PART

Part Number 1281384-101 Nomenclature Spoiler

Nonrecurring	Metal	Composite
Design Engineering	$118,486	$128,104
Basic Tooling	90,898	63,905
Total Nonrecurring Costs	$209,384	$192,009

	Quantity of Spoilers					
	8		101		200	
	Sheet Metal	Composite	Sheet Metal	Com-Posite	Sheet Metal	Composite
Sustaining Engineering	$ 1,092	$ 819	$ 405	$ 167	$ 282	$ 123
Sustaining Tooling	1,089	572	287	190	211	135
Materials	639	1,300	491	992	456	922
Manufacturing	3,209	1,681	1,463	965	1,262	856
Quality Assurance	497	393	189	257	153	240
Average Recurring	$ 6,526	$ 4,765	$2,832	$2,571	$2,364	$2,276
Average Nonrecurring	26,173	24,001	2,073	1,901	1,047	960
Total Manufacturing Cost	$32,699	$28,766	$4,905	$4,471	$3,411	$3,236

Developmental Cost Comparison

The initial five composite spoilers were used to develop and qualify the production process. A cost tracking system was conducted during the development phase to compare the cost of the composite spoiler to the cost of the initial five metal spoilers. This comparison is made in Table XXIV using the labor rates for the development spoiler to establish a common time frame.

Progress Curves

The progress curve or learning curve is applicable on all non-automated production lines. The initial component has the highest cost since the personnel are not familiar with the details of the component, the production process, or the tools. After the first operation is complete, the operators gain confidence and begin to reduce the manhours required to complete the

TABLE XXIV - COST COMPARISON OF FIRST FIVE SPOILERS

FUNCTIONAL COST ELEMENTS	S-3A COMPOSITE SPOILERS 5 DEVELOPMENTAL SPOILERS						S-3A METAL SPOILERS INITIAL 5 SPOILERS					
	Non recurring	Unit No.					Non recurring	Unit No.				
		1	2	3	4	5		1	2	3	4	5
Engineering												
Manhours	6,118	40	42	32	32	28	5,424	86	72	60	46	48
Departmental Costs ($)	111,321	712	748	571	571	500	109,077	1,565	1,308	1,092	836	873
Manufacturing Engr.												
Manhours	2,294	40	46	40	36	31	4,060	78	68	68	44	58
Departmental Costs ($)	44,988	766	881	766	690	594	80,610	1,513	1,320	1,320	854	1126
Manufacturing												
Manhours	1,721*	143	126	106	107	92	457*	290	245	220	205	185
Departmental Costs ($)	33,108	2751	2423	2038	2058	1769	8,684	5,512	4,656	4,181	3896	3516
Quality Assurance												
Manhours	310	35	38	31	32	31	252	50	45	43	41	39
Departmental Costs ($)	7,020	793	861	702	725	702	5,757	1,136	1,024	979	932	887
Materials												
Manhours	31	5	6	6	6	6	10	3	3	3	3	3
Direct Materials ($)	6,303	1147	1212	1272	1212	1212	2,000	571	571	571	571	571
Departmental Costs ($)	7,511	1357	1446	1446	1446	1446	2,378	681	681	681	681	681
Manufacturing Costs ($)	203,948	6379	6359	5523	5490	5011	206,506	10,407	8989	8253	7199	7083

NOTES: Nonrecurring costs here do not match those shown in Table XXIII for the following reasons:

1. Labor and overhead rates for the first five composite spoilers shown in this table are actuals accumulated during the current contract (For comparison purposes the five metal spoilers were calculated using the same rates). The labor and overhead rates for projected quantities of metal and composite spoilers in Table XXIII are projected 1975 labor and overhead rates.
2. "One time" only costs for materials and process development are included in the nonrecurring costs for the five composite spoilers. This is not included in the projected nonrecurring costs in the Table XXIII.

* Cost of test specimens is included in composite nonrecurring; is not in metal nonrecurring

AD-A032 816 LTV AEROSPACE CORP DALLAS TEX VOUGHT SYSTEMS DIV F/G 1/3
S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM. VOLUME 1.(U)
AUG 74 O E DHONAU, E G BLOSSER N62269-73-C-0610
UNCLASSIFIED 2-53443/4R-3172-VOL-1 NADC-75141-30-VOL-1 NL

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1.0 4.5 5.0 5.6 6.3 7.1 2.8 3.2 3.6 4.0 2.5 2.2 2.0 1.1 1.8 1.25 1.4 1.6

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

9 8 7 6 5 4

required processes. In addition, the production lot sizes may increase which permits amortizing the tool setup time over more articles and further reduce the time per part. In any event, the reduction of time with each succeeding article has been described as learning curves, or progress curves. Factory labor is measured by progress curves, and raw materials are purchased to a curve which is usually the result of purchases of large quantities of materials and reduced packaging. The learning curves for these important cost drivers are further explained in succeeding paragraphs.

PROGRESS CURVES

Factory Labor

Factory labor is a key cost contributor as noted in Figures 62 and 63. The initial components require more manhours than subsequent units. The degree of improvement is a function of the skills of the craftsman, familiarity with the manufacturing process, number of operations - by hand and by machine, design complexity, producibility changes to reduce factory labor, lot sizes, production rate, and similar factors.

The factory labor progress curve for the sheet metal spoiler approximates an 84% slope and is predicated upon the data acquired during the fabrication of the first 53 sets. An 84% learning factor reflects less improvement than the 80% which would normally be expected for a sheet metal assembly. This is primarily due to the complex sheet metal assembly which has many detail parts and is difficult to assemble. The complexity of the assembly does not lend itself to efficient production procedures.

The factory labor progress curve for the graphite assembly is on an 87% slope. This is based upon the data from the fabrication of the first five graphite spoilers. This slower progress rate is in a large part due to factors inherent in the bonding process, which do not lend themselves to a decrease in cycle time. These include the lay-up, bagging and autoclave operations. Lay-up and bagging (applying the vacuum barrier materials to the mold) are hand operations and the curing cycle is a fixed time element.

Raw Materials

The progress curve for both the sheet metal and composite raw materials is 92%. This 92% curve is historical for aluminum structure at VSD, and the same curve was selected for graphite epoxy. Material costs are constant

for the first five graphite spoilers because the material was procured in one buy. Cost decrease will be reflected in succeeding lots as the quantity of material procured is increased. The curve for graphite may become a steeper curve as additional manufacturing capacity is added by the raw material fabricators. However, since the estimate was made using constant 1975 dollars, the 92% progress curve was employed.

Trade Studies

Several trade studies were conducted to determine the impact on cost for the composite spoiler. Since factory labor and raw material are the primary cost contributors for 200 units, these factors were analyzed to determine the impact on manufacturing cost for 200 articles should the other cost elements remain constant.

The study for factory labor with all other cost elements constant is graphically shown by Figure 64. Basically, an increase or decrease of 10% in factory labor will change the manufacturing cost for the composite spoiler by ±3.8%.

The study for raw material with all other cost elements constant is graphically shown on Figure 65. An increase or decrease in cost of raw materials by 10% will result in a change of the manufacturing cost for the composite spoiler by ± 4.1%.

Composite Raw Material

The effect of a changing total material cost has been described previously. However, a study was conducted to determine the impact of changing the cost of graphite epoxy. For the basic study, graphite epoxy raw material cost was priced to VSD at $67 per pound. Since demand and production capacity are expected to increase, the manufacturers of graphite/epoxy materials are projecting significant price reductions. A material cost of $30 per pound was selected for the graphite/epoxy cost; the cost for the remaining materials were kept constant. As a result, the raw material was reduced by approximately 35%. This reduction in raw material will reduce the cost for 200 spoilers by 14%. The cost curve for composite spoiler with $30 per pound graphite epoxy material is shown on Figure 61.

Core Material

The core for the spoilers is Hexcel's "HRP" core. This core was selected to

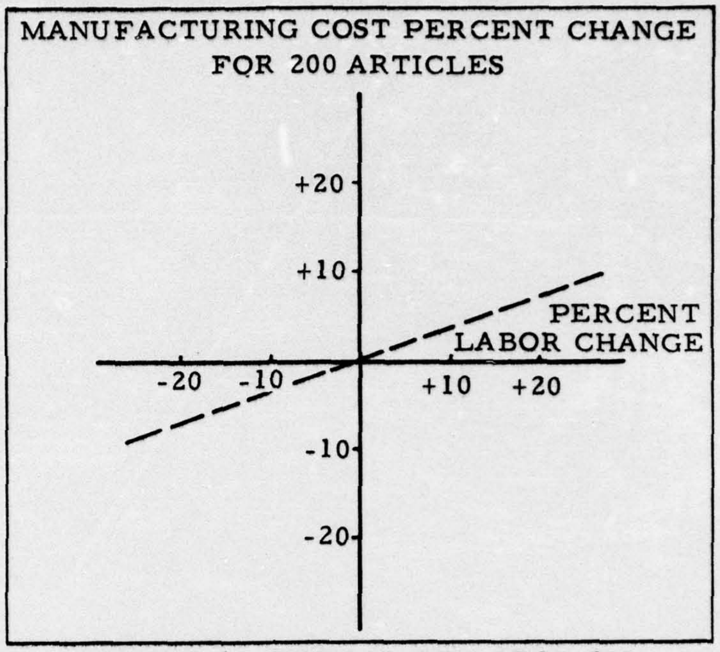


FIGURE 64 EFFECT OF LABOR ON COMPOSITE SPOILER MANUFACTURING COST

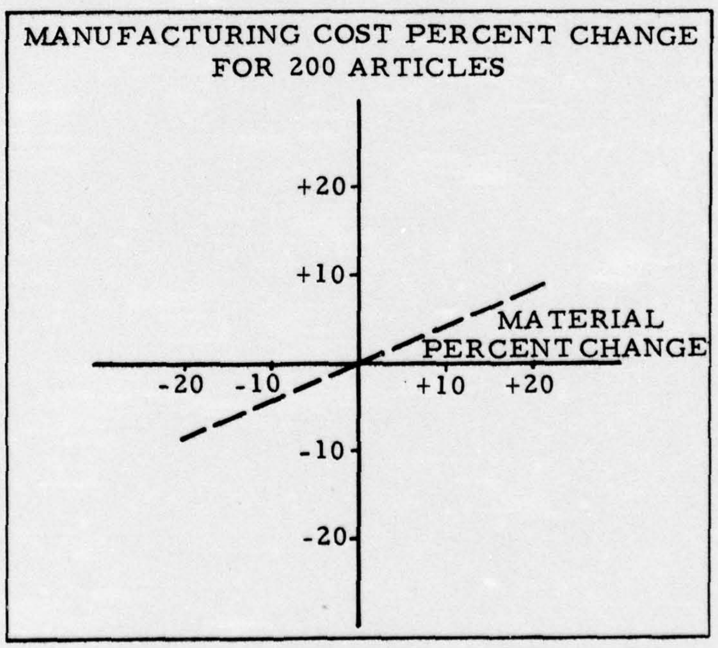


FIGURE 65 EFFECT OF MATERIAL ON COMPOSITE SPOILER MANUFACTURING COST

eliminate the corrosion interface with the graphite/epoxy; however, the "HRP" core is more costly than aluminum alloy core. A study was made to determine the initial cost savings possible for 200 spoilers if the aluminum core had been specified. The material cost would be 11% less when aluminum alloy core is specified. The 11% reduction in material costs for 200 articles will reduce the manufacturing cost approximately 4.5%.

APPENDIX A

ENGINEERING DRAWINGS

This appendix contains the following S-3A composite spoiler drawings and the tool drawings from which the parts were fabricated.

- 78-002553 - Flap S-3A Spoiler Lower Outer Panel Advanced Composites
- 78-002554 - Core Assembly S-3A Outer Panel Lower Spoiler Advanced Composites
- S/N 405011 - 082 - 78-002553 Bonding Mold

RLSE AUTH 10261.2

A REMOVED -3, -4, -5, -6
REVISED & RENUMBERED NOTES.
REMOVED ALL 4.0# CORE
REVISED STOCK SIZE & WT. OF -2
ADDED NOTES 6&7
ADDED M3

DWG BY.
J. E. [illegible]
GROUP
J. E. [illegible]
STR.
[illegible]
MFG/R&D.
BLOSSER
PROJ.
[illegible]

FIGURE A-1 CORE ASSEMBLY
S-3A OUTER PANEL LOWER SPOILER
PAGE 1 OF 4

OFFICIAL
ENGINEERING
RELEASE

B.W. Staff	9-27-70
BLOSSER	20 SEPT 73
[illegible]	9/20/73

VOUGHT AERONAUTICS DIVISION
LTV AEROSPACE CORPORATION
P.O. BOX 5907 - DALLAS, TEXAS 75222

NOTES:

1. HONEYCOMB CORE 3/16 - 5.5# CVA207-8-411 CLASS I, TYPE I GR
2. CORE SPLICE FOAM ADHESIVE VSD 207-8-408 TYPE
3. FOR CONTOURS SEE 78-002553
4. CORE SPLICE APPLY & CURE VSD 207-8-408 (TYPE III) F
5. TOLERANCE ON CORE THICKNESS ±.008, ON TRIM ±.03,
6. DIP PERIPHERY EDGES OF CORE IN SC1008 PHE
7. PHENOLIC RESIN SC1008 MONSANTO CHEMICAL

CONTR NO.	
N62269-73-C-0610	VOUGHT AERONAU A Division of LTV Aer P.O. BOX 5907 - DALL

ASS I, TYPE I GRADE 5.5
-8-408 TYPE III

8-408(TYPE III) FOAM PER VSD 208-8-12
TRIM ±.03, ON ANGLES ±30"

SC 1008 PHENOLIC RESIN PER 208-7-18

D CHEMICAL CO. SEATTLE, WASH.

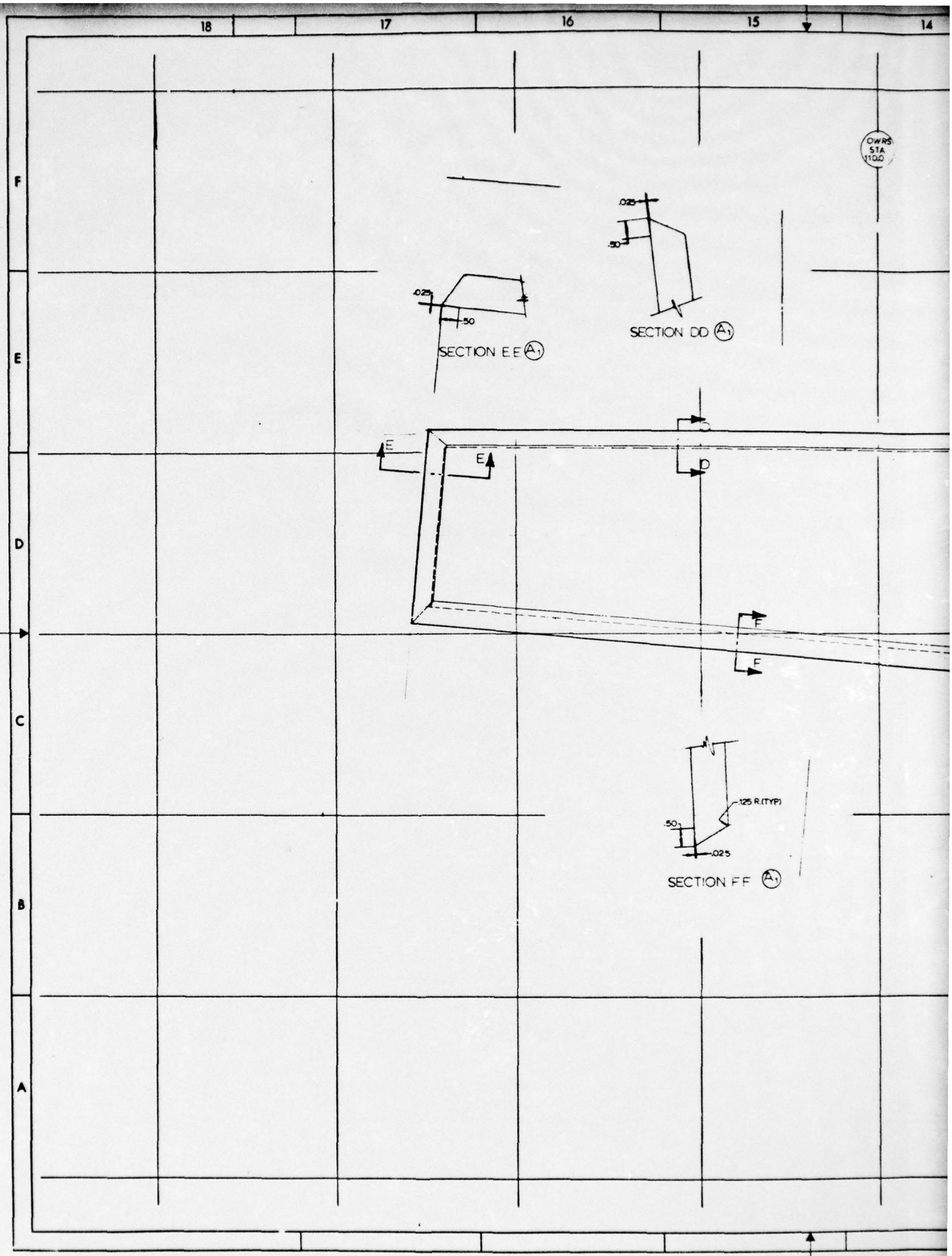
FIGURE A-1 (CONT'D) PAGE 2 OF 4

									AR				PHENOLIC RES
									AR				CORE SPLICE FILM ADHES
												-2	CORE
												-1	CORE AS
									-1	ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
QTY REQD PER DASH NUMBER													

LIST OF MATERIAL

NO.	NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE				UNIT WT	REV SYM
	PHENOLIC RESIN			M3		~	
	CORE SPLICE FILM ADHESIVE			M2		.07	
	CORE	.93×12.0×85.0		M1		1.93	A
	CORE ASSY					2.00	A

MATERIAL



18
17
16
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F
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A
OWRS STA 1100
.025
.50
SECTION DD A1
.025
.50
SECTION EE A1
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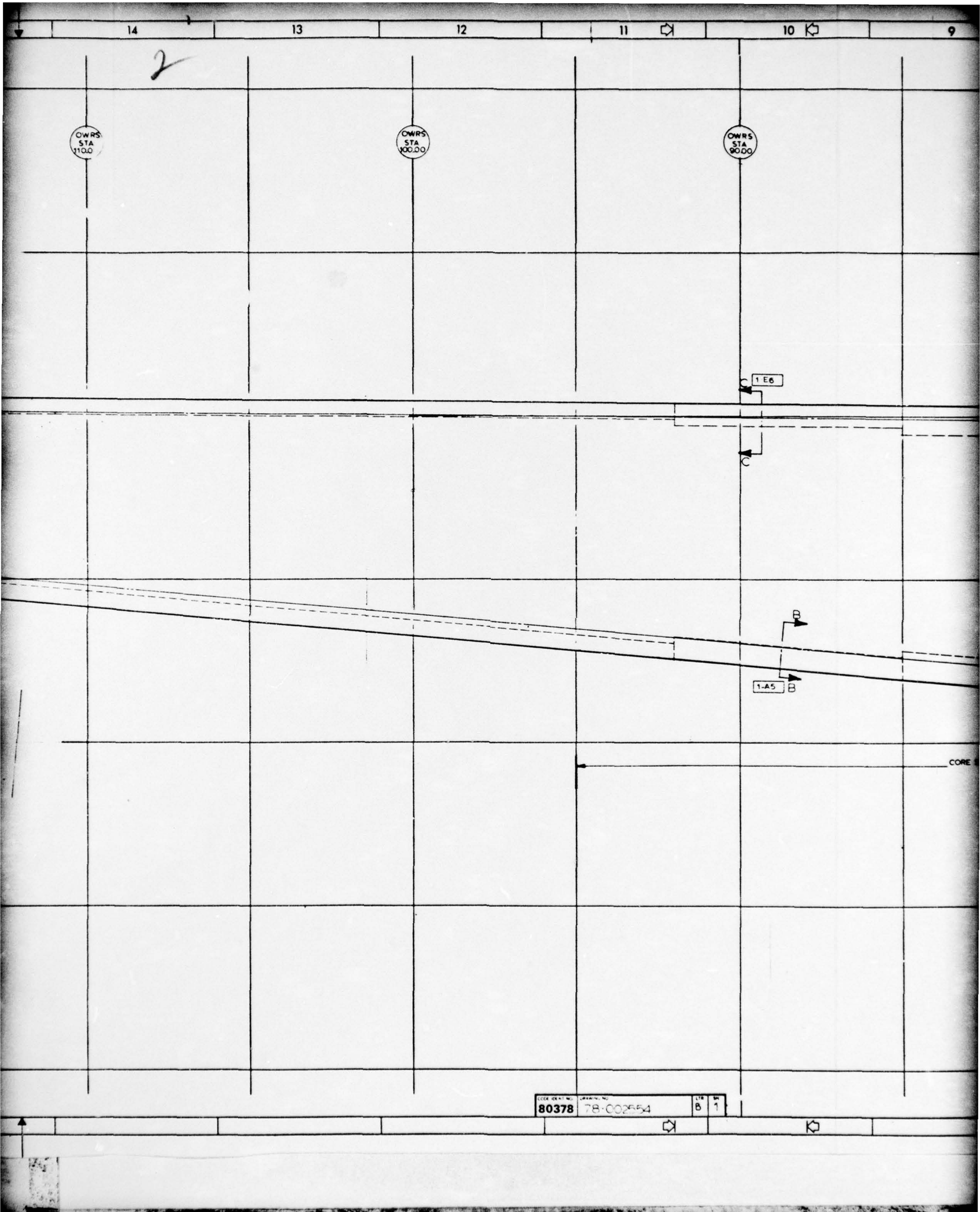
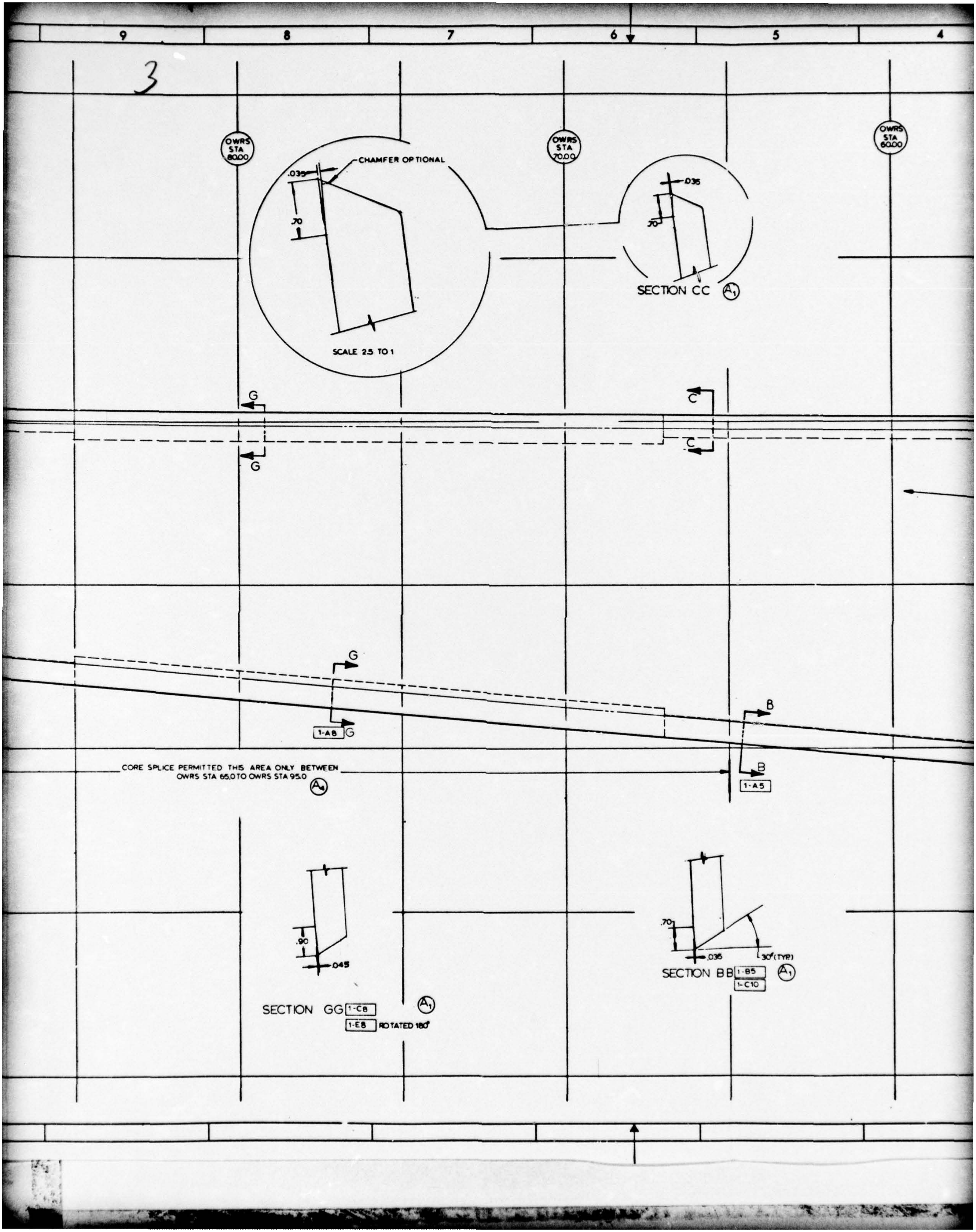
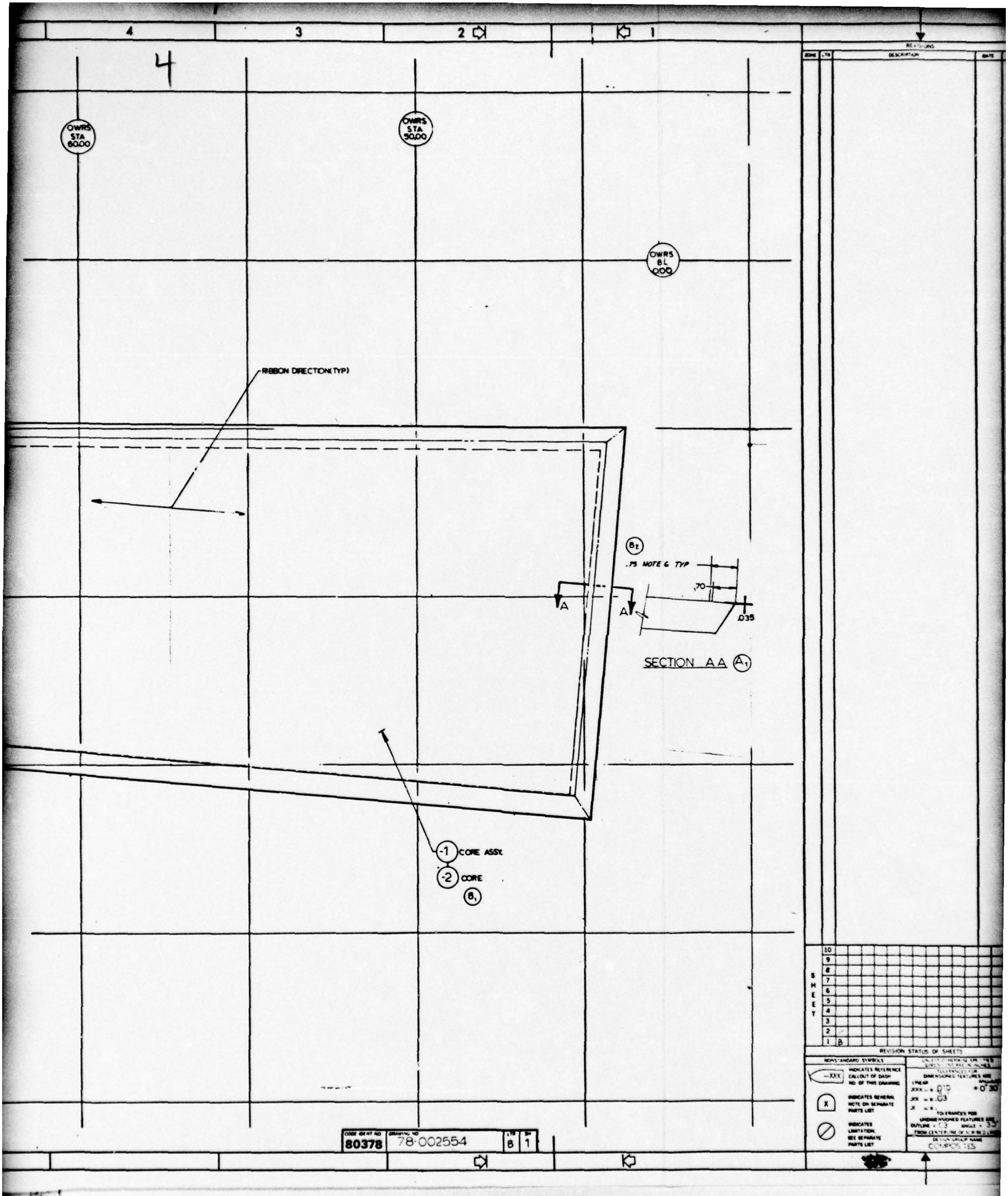
D
D
F
F
.125 R.(TYP)
.50
.025
SECTION FF A1

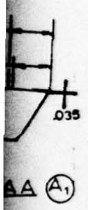

14
13
12
11
10
9
2
OWRS STA 110.0
OWRS STA 100.00
OWRS STA 90.00
1 E6
C
C
B
1-A5
B
CORE
CODE IDENT NO
DRAWING NO
LTR
SH
80378
78-002554
B
1



9
8
7
6
5
4
3
OWRS STA 80.00
OWRS STA 70.00
OWRS STA 60.00
CHAMFER OPTIONAL
.035
.70
SCALE 2.5 TO 1
.035
.70
SECTION CC A1
G
C
1-A8
B
1-A5
CORE SPLICE PERMITTED THIS AREA ONLY BETWEEN OWRS STA 65.0 TO OWRS STA 95.0
A4
.90
.045
SECTION GG 1-C8 1-E8 ROTATED 180°
A1
.70
.035
30° (TYP)
SECTION BB 1-B5 1-C10
A1


4
3
2
1
REVISIONS
ZONE
LTR
DESCRIPTION
DATE
OWRS STA 60.00
OWRS STA 50.00
OWRS BL 0.00
RIBBON DIRECTION(TYP)
B2
.75 NOTE 6 TYP
.70
A
A
.035
SECTION AA A1
-1 CORE ASSY.
-2 CORE
B1
SHEET
10
9
8
7
6
5
4
3
2
1 B
REVISION STATUS OF SHEETS
NONSTANDARD SYMBOLS
-XXX INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING
X INDICATES GENERAL NOTE ON SEPARATE PARTS LIST
INDICATES LIMITATION, SEE SEPARATE PARTS LIST
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES FOR DIMENSIONED FEATURES ARE
LINEAR
ANGULAR
.XXX = ±.010
±0°30'
.XX = ±.03
.X = ±.
TOLERANCES FOR UNDIMENSIONED FEATURES ARE
OUTLINE ±.03
ANGLE ±3°
FROM CENTERLINE OF VIEW REQUIRED
DESIGN GROUP NAME
COMPOSITES
CODE IDENT NO
80378
DRAWING NO
78-002554
LTR
B
SH
1

5



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
		RELEASE AUTHORITY 10261.		
8B	A	RELEASE AUTHORITY 10261 4 1. REVISED FOLLOWING SECTION DIMENSIONS: SECTION (NOW) (WAS) AA .035x.70 .045x1.00 BB .035x.70 .045x1.00 CC .035x.70 .045x1.00 DD .025x.50 .035x.70 EE .025x.50 .035x.70 FF .025x.50 .035x.70 GG .045x.90 .055x1.20 2. CORRECTED PLAN VIEW TO AGREE WITH SECTION CHANGES. 3. REMOVED -3, -4, -5, -6 FROM F/D 4. ADDED CORE SPLICE NOTE TO F/D		DWG BY GROUP STR MFG R&D PROJ.
8Z D1	B	RELEASE AUTHORITY ER10261.6 1. REVISED PERIPHERAL TRIM OF -1 & -2 CORE 2. ADDED ".75 NOTE 6 TYP"		DRAWN BY GROUP STE MFG ENG. Blouse PROJ.

REVISION STATUS OF SHEETS

SHEET	
10	
9	
8	
7	
6	
5	
4	
3	
2	
1	B

OFFICIAL ENGINEERING RELEASE

SEE SEPARATE PARTS LIST

NONSTANDARD SYMBOLS

- —XXX INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING
- (X) INDICATES GENERAL NOTE ON SEPARATE PARTS LIST
- ⊘ INDICATES LIMITATION SEE SEPARATE PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES FOR DIMENSIONED FEATURES ARE
LINEAR .XXX = ±.010 .XX = ±.03 .X = ±. ANGULAR ±0°30'

TOLERANCES FOR UNDIMENSIONED FEATURES ARE, OUTLINE ±.03 ANGLE ±30' FROM CENTERLINE OF SCRIBED LINES

DESIGN GROUP NAME: COMPOSITES

CONTR NO		
PREPARED	J.MADORIN	7-8-03
CHECKED		
GROUP	J.MADORIN	7-8-03
STRESS		
PROJ ENGR		
CUSTOMER		

VOUGHT SYSTEMS DIVISION
LTV AEROSPACE CORPORATION

CORE ASSY
S-3A O P LWR. SPOILER
ADVANCED COMPOSITES

SIZE	CODE IDENT NO	DRAWING NO
J	80378	78-002554

SCALE FULL REV LTR B SHEET 1

A B C D E F

78-002554

FIGURE A-1 (CONT'D) PAGE 4 OF 4

RLSE AUTH 10261.2

A. RELEASE AUTHORITY 10261.4

SHT.4 REVISED WT. ON -1, -3, -4, -5, -7, -8, -9, -10, -11

" MATL SIZE ON -5, -7, -8, -9, -10, -11

SHEET 3 ADDED NOTE # 24

DWG BY J.E.MADORIN

GROUP J.E.Madorin

STR J.S. Littlefield

MFG RLD BLOSSER

PROJ. OEDixon

OFFICIAL ENGINEERING RELEASE

MFG. RLD.	BLOSSER	20 SEPT 73
PROJ ENGR	OEDixon	9/20/73
STR DSGN	Littlefield	9/19/73
GROUP	MADORIN	9-19-73
CHK/BY MATL		
DRAWN BY	MADORIN	9-19-73
ENGRG UNIT NO. 2-51640		

VOUGHT AERONAUTICS DIVISION
LTV AEROSPACE CORPORATION
P O BOX 5907 · DALLAS, TEXAS 75222

FLAP
S-3A SPOILER LWR. O.P.
ADVANCED COMPOSITES

FIGURE A-2 FLAP S-3A SPOILER LOWER

1. L.H. PART ONLY SHOWN
2. GRAPHITE FILAMENT TAPE EPOXY RESIN IMPREGNATED VSD
3. FILM ADHESIVE VSD 207-8-415 TYPE II GRADE 10 (REQUEST ME
THIS PROGRA
4. HONEYCOMB CORE 3/16 - 5.5* CVA 207-8-411 CLASS 1 TYPE I GRAD
5. SEALANT CVA6-579
6. EPOXY ADHESIVE CVA 8-405 TYPE VI
7.
8. ALUMINUM SCREEN 5052-0 120 MESH (.004 WIRE DIA.) M
FROM PACIFIC WIRE WORKS INC.
9. PROCESS COMPOSITE EPOXY RESIN IMPREGNATED MATL PER
10. APPLY VSD 207-8-415 TYPE II GRADE 10 PER VSD 208-8-
11.
12. POT INSERTS WITH CVA8-405 TYPE VI PER CVA 8-260
13. APPLY FAYING SURFACE SEAL (CVA6-579) PER CVA6-177(1)
14. COAT EXPOSED HONEYCOMB WITH CVA6-579 SEALANT PER
15. CLEAN SCREEN PER CVA 8-51 METHOD II PRIOR TO LAYUP
16. APPLY FILLER TO EXTERIOR SURFACE PER LCP 78-205
EPOXY FILLER EPS 37.7250 (IF REQD FOR SMOOTHING
17. APPLY ANTI-STATIC COATING (CONDUCTIVE MATL EPS 3
37.7272) TO EXTERIOR SURFACE PER PB78-529 AND ON
MIL-C-23377 EPOXY PRIMER PER PB78-509.
18. NDT INSPECT FOR STRUCTURAL SOUNDNESS.
19. MAKE FROM MIL-P-15035 LAMINATED PLASTIC TY
20. CPC PAGE 10 R 8 HUCK MFG. CO. DETROIT MICHIGAN.

UATED VSD 207-8-410/1

(REQUEST METALBOND M-1113 FOR

THIS PROGRAM)

TYPE I GRADE 5.5

WIRE DIA.) MAY BE PURCHASED

D MATL PER VSD 208-8-3

SD 208-8-3

8-260

A6-177(1)

EALANT PER CVA 8-39(1)

R. TO LAYUP

LCP 78-2059 TYPE I UTILIZING

SMOOTHNESS)

MATL EPS 37.7270, 37.7274,

S AND ONE COAT OF

509.

IESS.

PLASTIC TYPE FBG

MICHIGAN.

NAS 523 RIVET CODE

XX XX
XXX XX

- BASIC CODE
- DASH NO. FOR DIAMETER
- N-MFG (PREFORMED) HEAD, NEAR SIDE
- F-MFG (PREFORMED) HEAD, FAR SIDE
- -BLANK INDICATES LOCATION OF MFG (PREFORMED) HEAD, OPTIONAL
- DASH NO. FOR LENGTH
- C-MACH CSK
- NO. OF SH (IF MORE THAN ONE) FORM CSK
- D-FORM CSK

INSTALL FASTENERS PER SPEC CVA13-225
UNLESS OTHERWISE NOTED

BASIC CODES

FIGURE A-2 (CONT'D) PAGE 2 OF 11

CONTRACT NUMBER

LTV VOUGHT AERONAUTICS DIVISION

LING-TEMCO-VOUGHT, INC. P.O. BOX 5907 DALLAS, TEXAS 75222

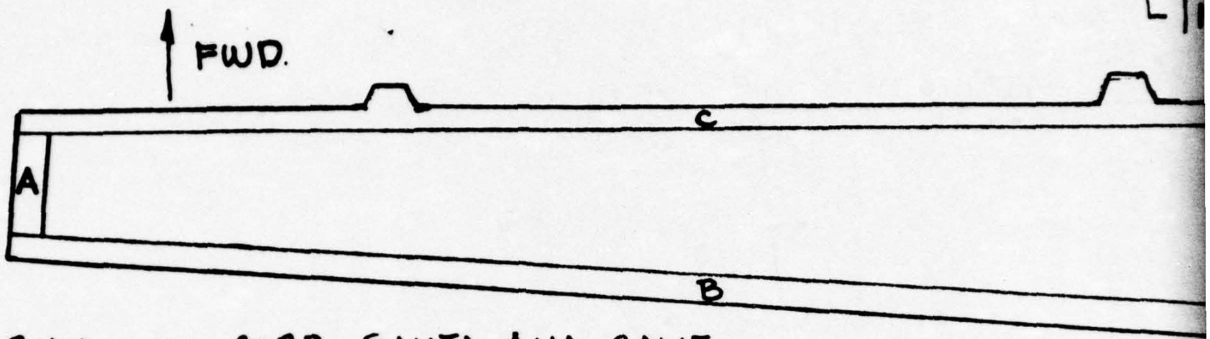
CODE IDENT NO.	SIZE	
80378	B	PL78-002553
SCALE NONE	REV SYM A 95	SHEET 2

21. PLY NUMBER IDENTIFICATION CODE

EXAMPLE :

BASIC PA

5P10B



22. SHUR-LOK CORP SANTA ANA, CALIF.

23. AFTER INSTL. TOUCH UP PER PB 78-510 (IF REQD.)

24. THE FOLLOWING PARTS ENCLOSED IN ( ) ARE IDENTICAL IN

(-8P12A -8P13A) (-9P10B -9P11B) (-10P12D -10P13D)

(-8P14A -8P15A) (-9P12B -9P13B) (-10P14D -10P15D)

(-9P14B -9P15B) (-10P16D -10P17D)

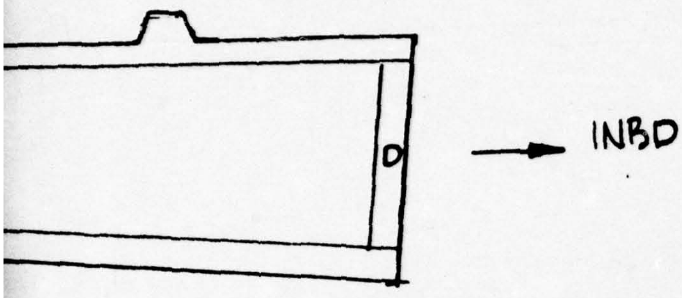
CONTR NO.	
N2269-73-C-0610	VOUGHT AERO A Division of LTV P.O. BOX 5907 -

BASIC PART NO.

AREA OF DWG WHERE PART LOCATED

5P10B

INDIVIDUAL PLY IDENT. NO.



).)

NTICAL IN OUTLINE AND DIFFER ONLY IN PLY ORIENTATION.

P12D) (-11P10C)
P 13D (-11P 11C)

P 14D) (-11P 12C)
P 15D) (-11P 13C)

P 16D) (-11P 14C)
P 17D) (-11P 15C)

FIGURE A-2 (CONT'D) PAGE 3 OF 11

										ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
					1					4-A6		-14	CORE OUTBD
						1				4-C6		-13	CORE INBD
									1	2-B7		-12	SEAL
								1		2-E12		-11	DOUBLER
								1		2-B18		-10	DOUBLER
								1		2-B9		-9	DOUBLER
								1		2-D1		-8	DOUBLER
								1		2-B5		-7	SKIN LWR
												-6	UNASSIGN
							1			1-B8		-5	SKIN U
									1	1-B8		-4	SKIN ASSY
									1	2-B12		-3	SKIN ASSY
												-2	UNASSIGN
										1-B8		-1	FLAP ASSY
					-23	-22	-4	-3	-1				
QTY REQD PER DASH NUMBER													

LIST OF MATERIAL

USED ON	QTY REQD FINAL ASSY	NEXT ASSY	FROM	THRU	MATERIAL		SPECIFICATION
	TEST ONLY.				M1	NOTE 2	
					M2	NOTE 19	
					M3	NOTE 4	
					M4	NOTE 8	
					M5	NOTE 3	
					M6	NOTE 5	
					M7	NOTE 6	
					M9	NOTE 16	

2

Nomenclature or Description	Material or Note				Unit Wt	Rev Sym
CORE OUTBD ACT	.93×5.8×3.2	M3			.01	
CORE INBD ACT	.93×5.8×3.2	M3			.01	
SEAL	.20×2.2×85.0	M2			1.27	
DOUBLER	870 IN²	M1			.25	A
DOUBLER	112 IN²	M1			.01	A
DOUBLER	740 IN²	M1			.21	A
DOUBLER	58 IN²	M1			.02	A
SKIN LWR	6100 IN²	M1		21	1.76	A
UNASSIGNED						
SKIN UPR	7200 IN²	M1			2.10	A
SKIN ASSY UPR.					2.19	A
SKIN ASSY LWR					2.50	A
UNASSIGNED						
FLAP ASSY			F1	16, 17, 18	12.27	A

MATERIAL

Specification	Protective Finish	
	F1	NOTE 17

CONTRACT NUMBER N62269-73-C-0610

VOUGHT AERONAUTICS DIVISION
LTV AEROSPACE CORPORATION
P O BOX 5907 · DALLAS, TEXAS 75222

CODE IDENT NO.	SIZE	
80378	B	PL 78-002553
SCALE NONE	REV SYM A 97	SHEET 4

									1		4-A5	-23	TAB ASSY C
									1		4-C5	-22	TAB ASSY
								1			2-F5	-21	SCREEN
							1				3-F5	-20	DOUBLER INB
							1				1-E12	-19	DOUBLER OUTB
									1		4-D5	-18	SHIM INBD
									1		4-B5	-17	SHIM OUTB
					1						4-C7	-16	SKIN OUTB
						1					4-D6	-15	SKIN INBD
					-23	-22	-4	-3	-1	ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTIO
QTY REQD PER DASH NUMBER													

LIST OF MATERIAL

USED ON	QTY REQD FINAL ASSY	NEXT ASSY	FROM	THRU		MATERIAL	SPECIFICATION

15.49d 11 x 17
2-69546

2

NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE				UNIT WT	REV SYM
TAB ASSY OUTBD				18	.02	
TAB ASSY INBD				18	.02	
SCREEN		M4		8, 15,16	.25	
DOUBLER INBD ACT	120 IN²	M1			.04	
DOUBLER OUTBD ACT	172 IN²	M1			.05	
SHIM INBD ACT	.062 × 2.6 × 9.4		23	MIL-S-22499 COMP I TYPE I	.05	
SHIM OUTBD ACT	.062 × 3.0 × 5.8		23	MIL-S-22499 COMP I TYPE I	.03	
SKIN OUTBD TAB	26 IN²	M1			.01	
SKIN INBD TAB	26 IN²	M1			.01	

ATERIAL

PECIFICATION | PROTECTIVE FINISH

CONTRACT NUMBER
N2269-73-C-0610

VOUGHT AERONAUTICS DIVISION
LTV AEROSPACE CORPORATION
P O BOX 5907 · DALLAS, TEXAS 75222

CODE IDENT NO.	SIZE	
80378	B	PL78-002553
SCALE NONE	REV SYM A 98	SHEET 5

FIGURE A-2 (CONT'D) PAGE 5 OF 11

										EPOXY ADHESI
										SEALANT
										FILM ADHESIV
						66		29666	100V 5D	RIVET
						14			SL607-4-105	INSERT
						14			NAS6304U3	BOLTS
						1			1281508-101	HINGE
						1			1281507-101	HINGE
						1			78-002554-1	CORE ASS
		-23	-22	-4	-3	-1	ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
REQD PER DASH NUMBER										

LIST OF MATERIAL

D.	NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE				UNIT WT	REV SYM
	FILM ADHESIVE		M5			.70	
	RIVET				20	.03	
	INSERT					.11	
	BOLTS					.18	
01	HINGE				15	.94	
	HINGE				15	1.46	
	CORE ASSY					2.00	A

MATERIAL

SPECIFICATION	PROTECTIVE FINISH	

CONTRACT NUMBER
N62269-73-C-0610

VOUGHT AERONAUTICS DIVISION
LTV AEROSPACE CORPORATION
P O BOX 5907 · DALLAS, TEXAS 75222

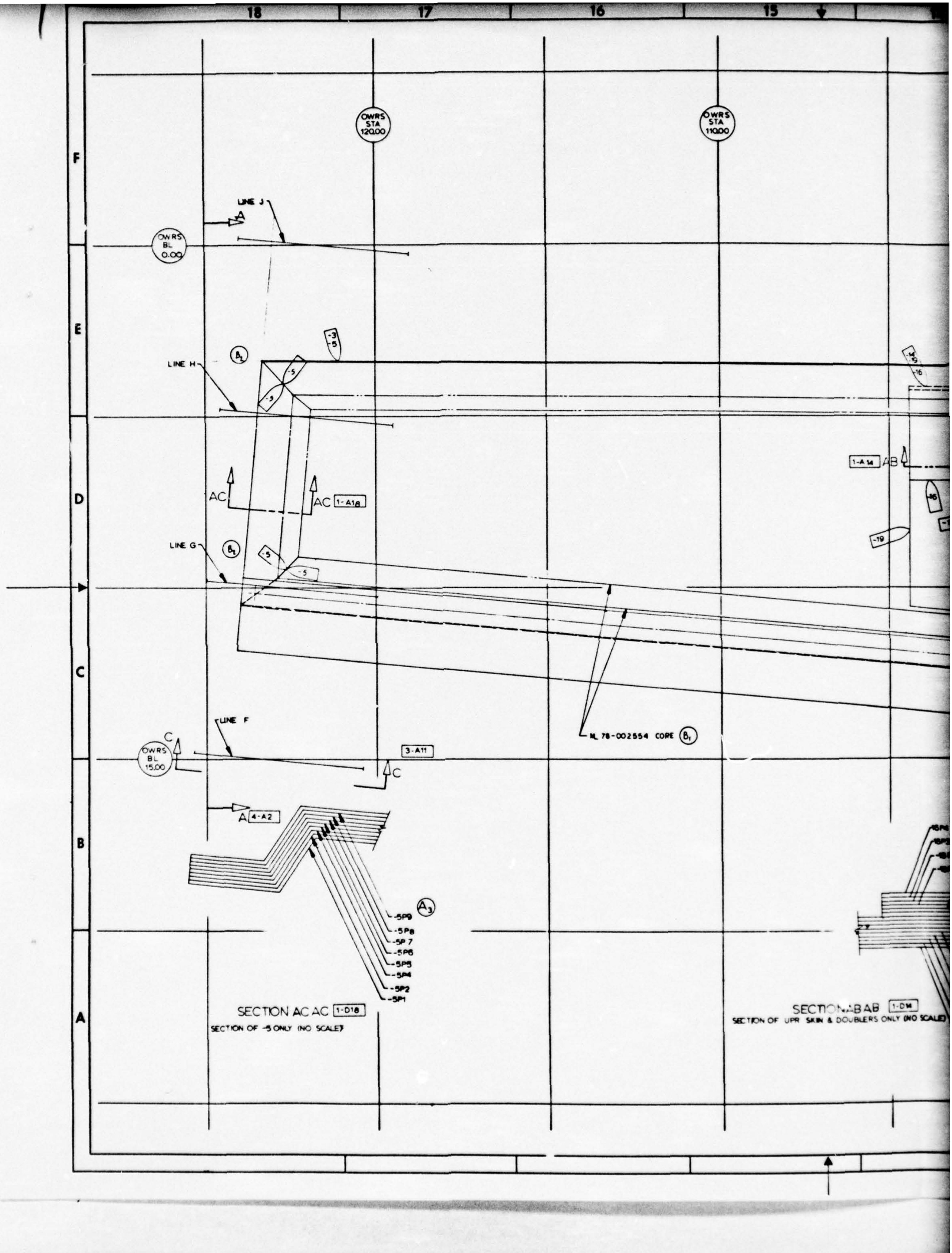
CODE IDENT NO.	SIZE	
80378	B	PL 78-002553
SCALE NONE	REV SYM A 99	SHEET 6

-23	-22	-4	-3	-1	ZONE	CODE IDENT	PART OR IDENTIFYING NO.	NOMENCLATURE DESCRIPTION
								EPOXY FILLET

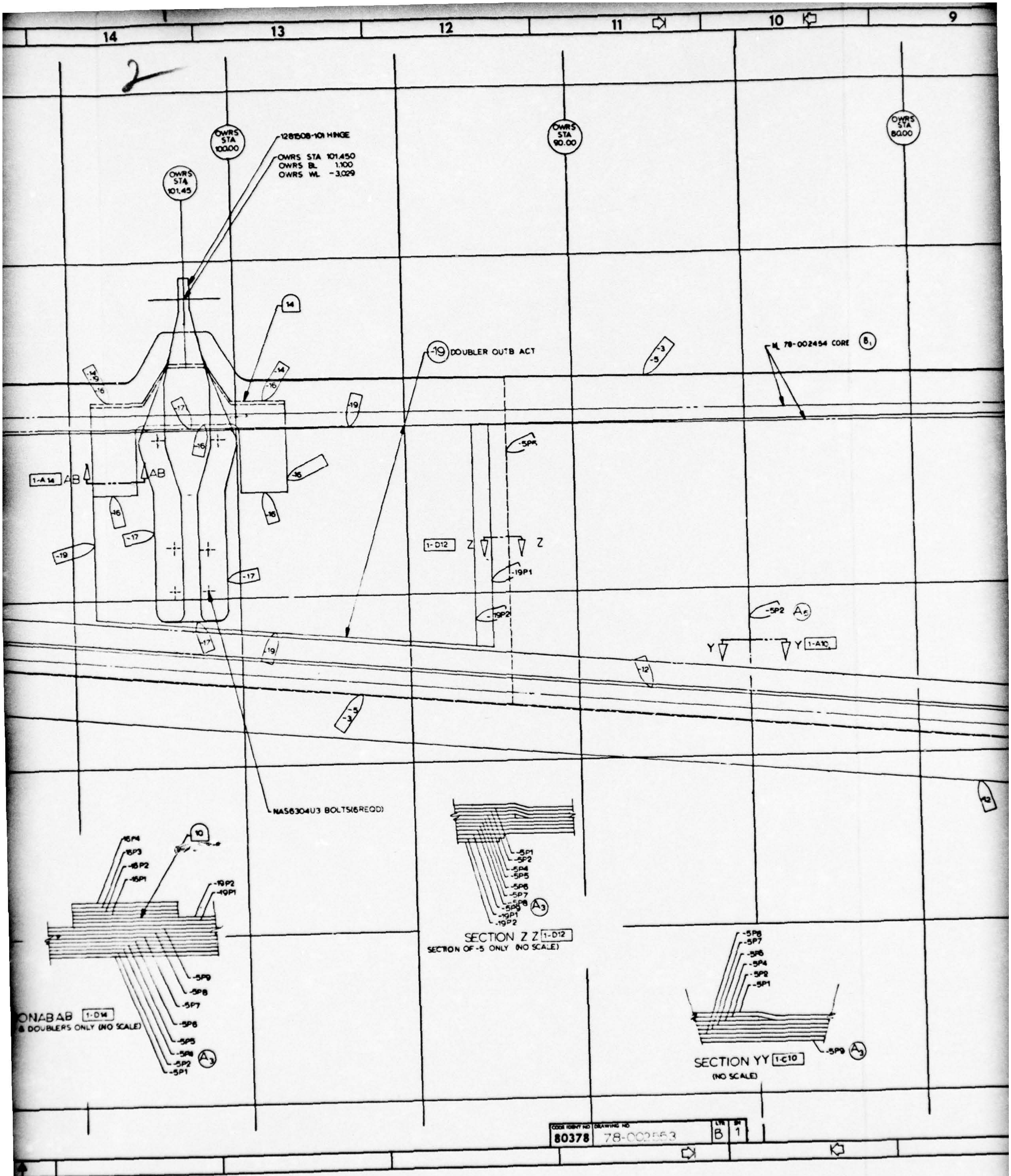
DASH NUMBER

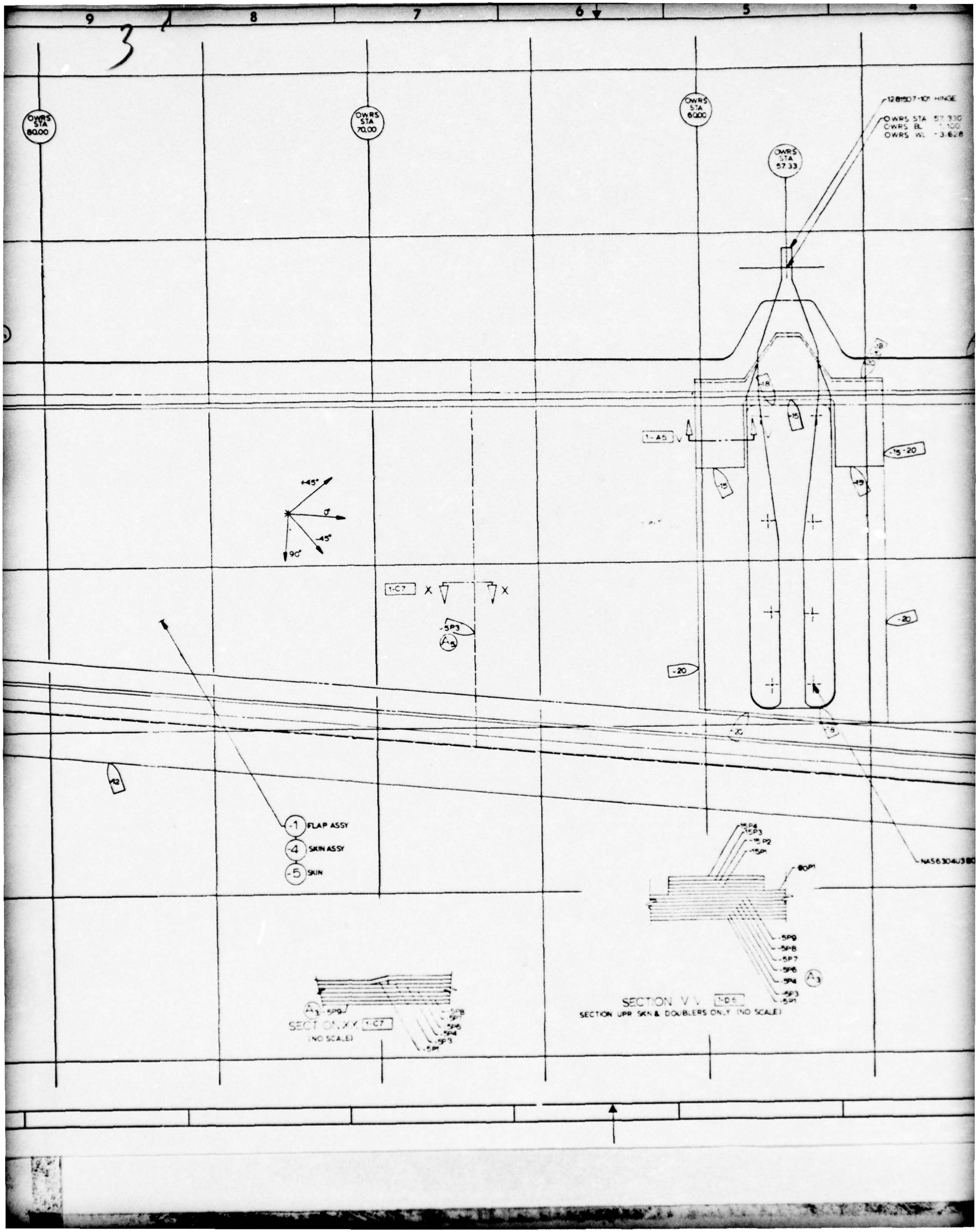
NOMENCLATURE OR DESCRIPTION	MATERIAL OR NOTE				UNIT WT	REV SYM
EPOXY FILLER		M9		16	—	

MATERIAL

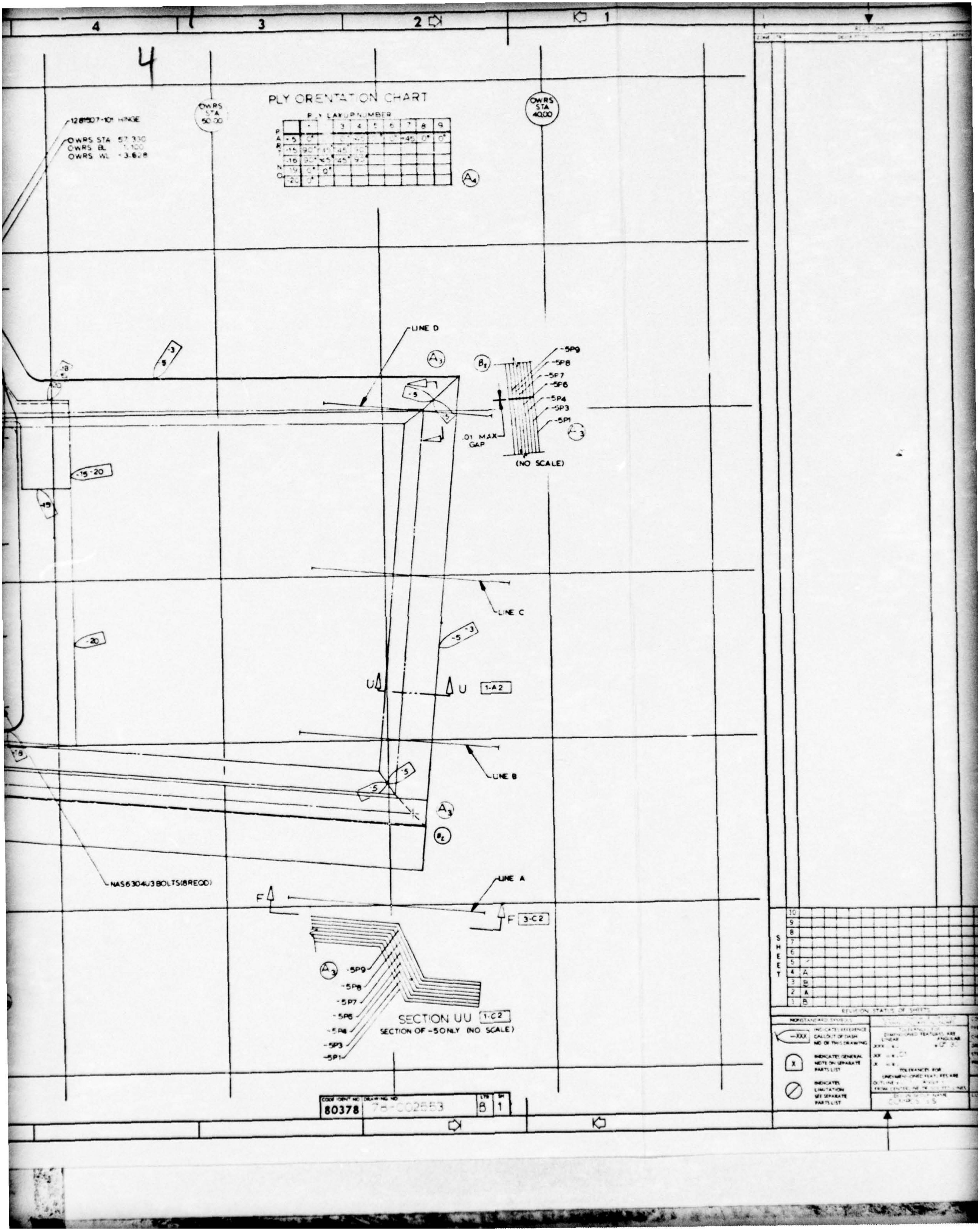


18
17
16
15
F
E
D
C
B
A
OWRS STA 120.00
OWRS STA 110.00
OWRS BL 0.00
OWRS BL 15.00
LINE J
LINE H
LINE G
LINE F
AC
AC 1-A18
1-A14 AB
3-A11
A 4-A2
NL 78-002554 CORE
-5P9
-5P8
-5P7
-5P6
-5P5
-5P4
-5P2
-5P1
SECTION AC AC 1-D18
SECTION OF -5 ONLY (NO SCALE)
SECTION AB AB 1-D14
SECTION OF UPR SKIN & DOUBLERS ONLY (NO SCALE)


14
13
12
11
10
9
2
OWRS STA 101.45
OWRS STA 100.00
OWRS STA 90.00
OWRS STA 80.00
1281508-101 HINGE
OWRS STA 101.450
OWRS BL 1.100
OWRS WL -3.029
-19 DOUBLER OUTB ACT
78-002454 CORE
1-A14 AB
AB
1-D12 Z
Z
Y
Y 1-A10
-19P1
-19P2
-5P2
NAS6304U3 BOLTS(6 REQD)
SECTION Z Z 1-D12
SECTION OF -5 ONLY (NO SCALE)
-5P1
-5P2
-5P4
-5P5
-5P6
-5P7
-5P8
-5P9
-19P1
-19P2
-16P4
-16P3
-16P2
-16P1
-19P2
-19P1
-5P9
-5P8
-5P7
-5P6
-5P5
-5P4
-5P2
-5P1
ONABAB 1-D14
& DOUBLERS ONLY (NO SCALE)
-5P8
-5P7
-5P6
-5P4
-5P2
-5P1
-5P9
SECTION YY 1-C10
(NO SCALE)
CODE IDENT NO 80378
DRAWING NO 78-002553
LTR B
SH 1



9
8
7
6
5
4
3
OWRS STA 80.00
OWRS STA 70.00
OWRS STA 60.00
OWRS STA 57.33
12B1507-101 HINGE
OWRS STA 57.330
OWRS BL 1.100
OWRS WL -3.628
-18
-20
-15
1-A5
V
-15 -20
+45°
0°
-45°
90°
1-C7
X
-5P3
A5
-12
-1 FLAP ASSY
-4 SKIN ASSY
-5 SKIN
NAS6304U3 BO
-15P4
-15P3
-15P2
-15P1
-80P1
-5P9
-5P8
-5P7
-5P6
-5P4
-5P3
-5P1
A3
SECTION V-V 1-D5
SECTION UPR SKN & DOUBLERS ONLY (NO SCALE)
SECTION X-X 1-C7
(NO SCALE)


4
3
2
1
PLY ORENTATION CHART
PLY LAYUP NUMBER
PART NO
-5
-15
-16
-19
-20
OWRS STA 50.00
OWRS STA 40.00
-128507-101 HINGE
OWRS STA 57.330
OWRS BL 1.100
OWRS WL -3.628
LINE D
-5P9
-5P8
-5P7
-5P6
-5P4
-5P3
-5P1
.01 MAX GAP
(NO SCALE)
-15 -20
-20
LINE C
U
1-A2
LINE B
NAS6304U3 BOLTS(8 REQD)
LINE A
F
3-C2
SECTION UU
1-C2
SECTION OF -5 ONLY (NO SCALE)
REVISION STATUS OF SHEETS
SHEET
NONSTANDARD SYMBOLS
INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING
INDICATES GENERAL NOTE ON SEPARATE PARTS LIST
INDICATES LIMITATION SEE SEPARATE PARTS LIST
CODE IDENT NO
DRAWING NO
80378
LTR
B
SH
1

5

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
		RELEASE AUTHORITY 102612		
	A	RELEASE AUTHORITY 102614 1. ADDED A 0° PLY NUMBERED -5P6 2. RENUMBERED FOLLOWING PARTS: (NOW) (WAS) -5P7 -5P6 -5P8 -5P7 -5P9 -5P8 3. CHANGED ALL VIEWS AND SECTIONS TO REFLECT THE ABOVE CHANGES		DWG BY GROUP STR MFG R&D PROJ
2F		4. REVISED PLY ORIENTATION CHART TO REFLECT NEW AND REIDENTIFIED PLY NUMBERS		
7C		5. INCORPORATED EO 102613		
	B	RELEASE AUTHORITY 102616		DWG BY G. MARTINEZ
		1. ADDED "M 78-002554 CORE"		GROUP
		2. REVISED CORNER TRIM OF -5		STR MFG R&D PROJ SEE

OFFICIAL ENGINEERING RELEASE

SHEET	REV
10	
9	
8	
7	
6	
5	
4	A
3	B
2	A
1	B

REVISION STATUS OF SHEETS

SEE SEPARATE PARTS LIST

NONSTANDARD SYMBOLS

-XXX INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING

(X) INDICATES GENERAL NOTE ON SEPARATE PARTS LIST

⊘ INDICATES LIMITATION SEE SEPARATE PARTS LIST

TOLERANCES FOR DIMENSIONED FEATURES ARE LINEAR ANGULAR

TOLERANCES FOR UNDIMENSIONED FEATURES ARE

DESIGN GROUP NAME COMPOSITES

CONTRACT NO / PREPARED / CHECKED / GROUP / STRESS / PROJ ENGR

CUSTOMER

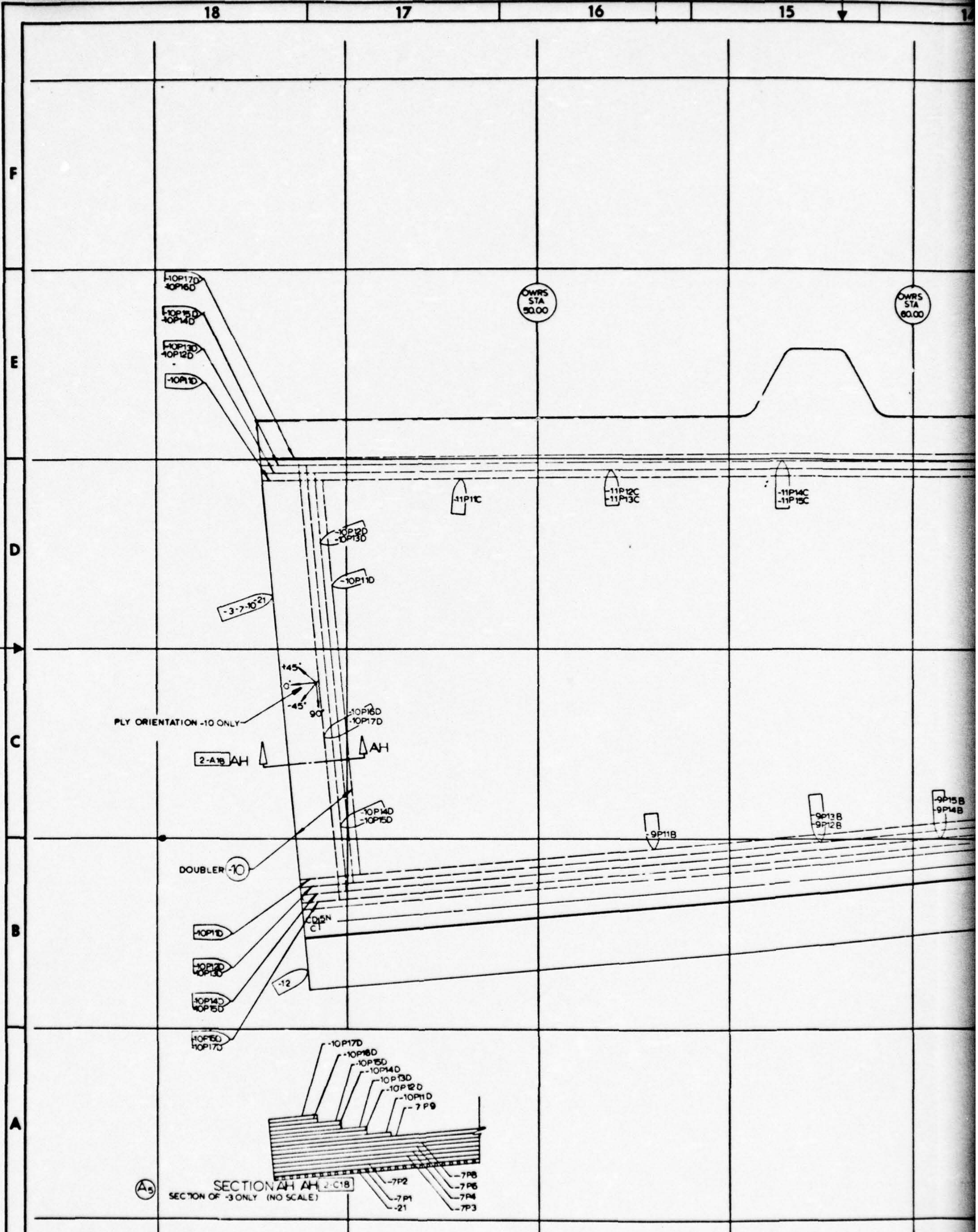
VOUGHT AERONAUTICS COMPANY
LTV AEROSPACE CORPORATION
P.O. BOX 5907 DALLAS TEXAS

FLAP
S-3A SPOILER LWR OP
ADVANCED COMPOSITES

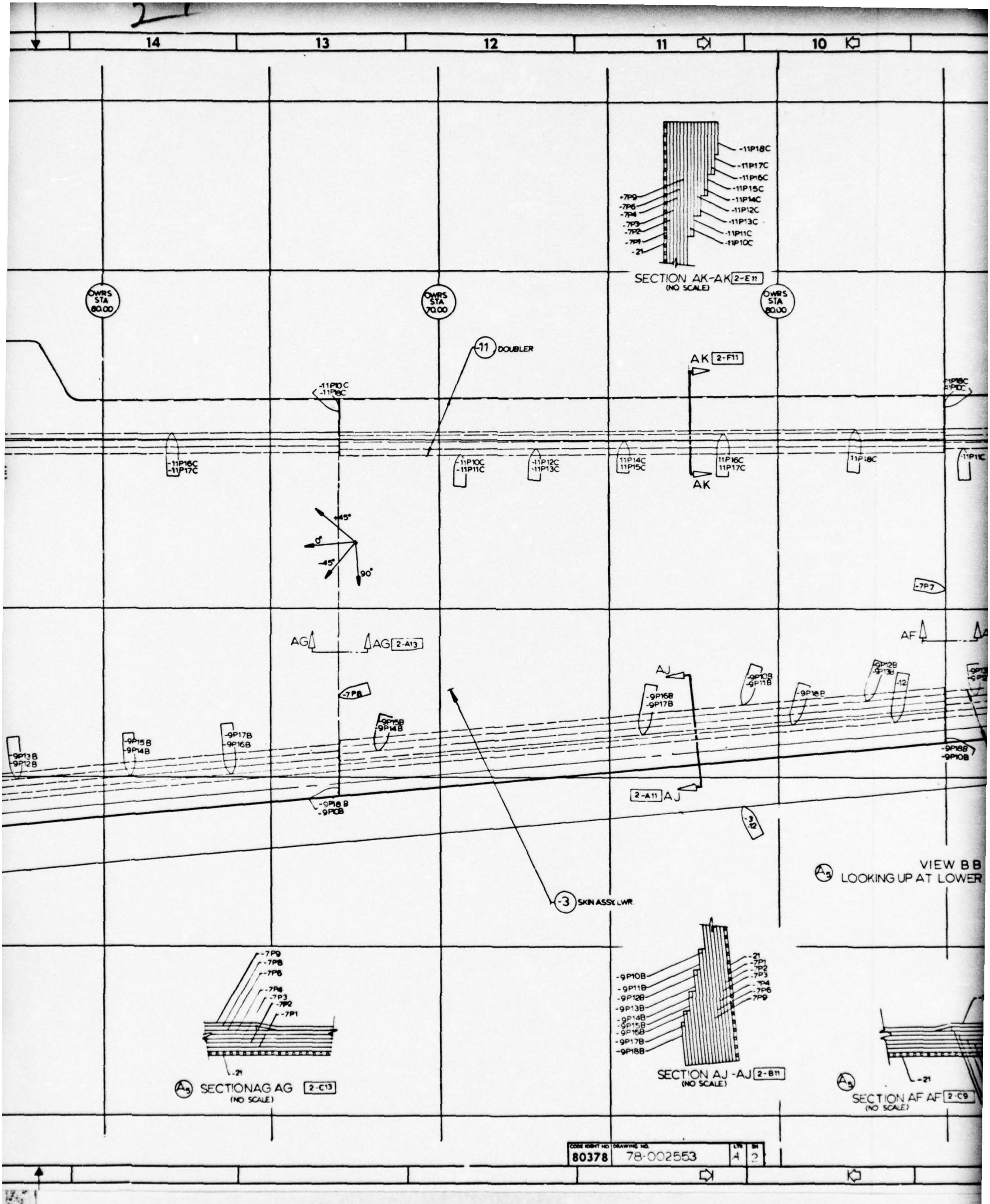
SIZE	CODE IDENT NO	DRAWING NO
J	80378	78-002553

SCALE | REV LTR B | SHEET 1 OF 4

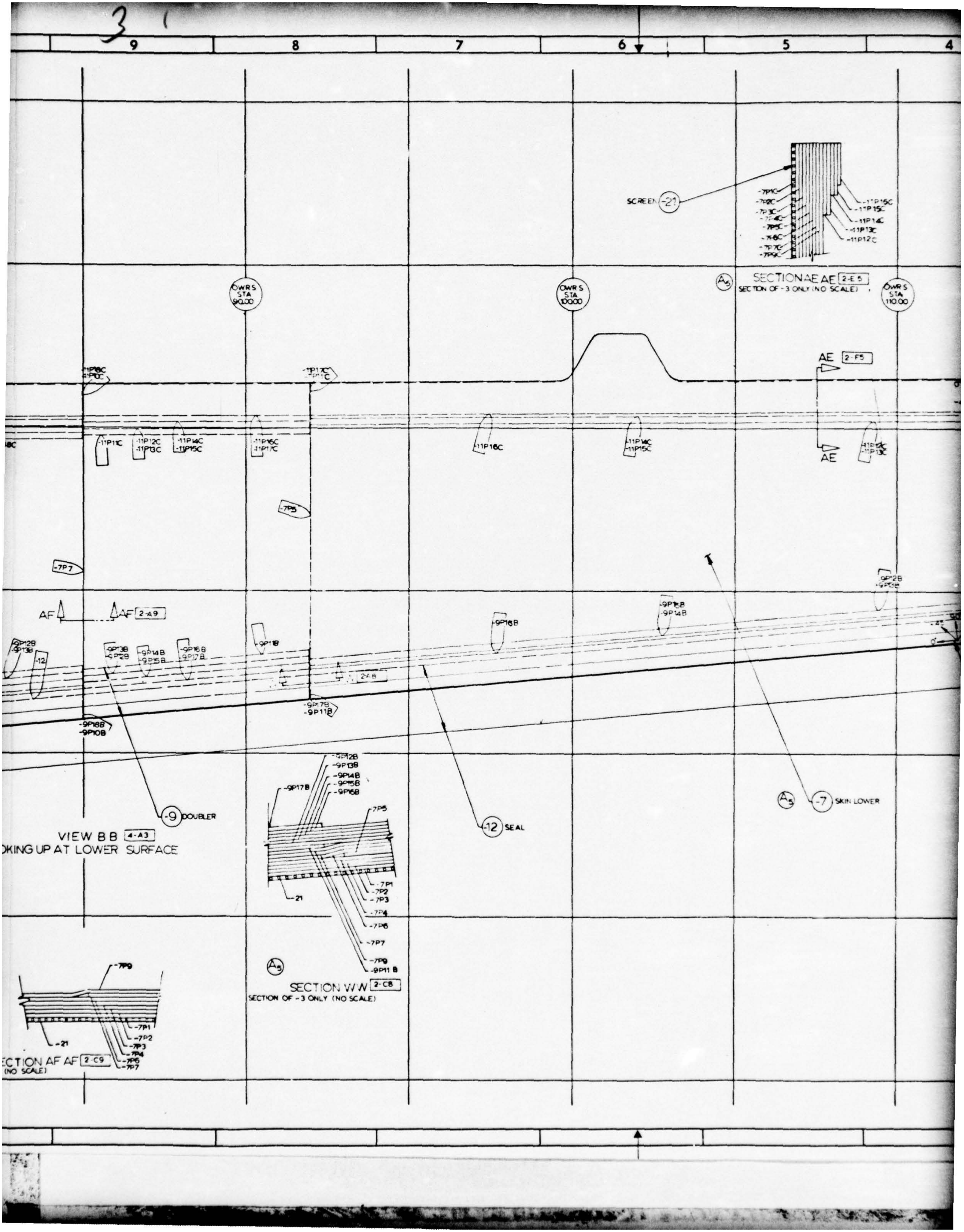
FIGURE A-2 (CONT'D) PAGE 8 OF 11



18
17
16
15
F
E
D
C
B
A
OWRS STA 50.00
OWRS STA 60.00
-10P17D
-10P16D
-10P15D
-10P14D
-10P13D
-10P12D
-10P11D
-11P11C
-11P12C
-11P13C
-11P14C
-11P15C
-10P12D
-10P13D
-10P11D
-3 -7 -10 -21
+45°
0°
-45°
90°
PLY ORIENTATION -10 ONLY
-10P16D
-10P17D
2-A18 AH
AH
-10P14D
-10P15D
-9P11B
-9P13B
-9P12B
-9P15B
-9P14B
DOUBLER -10
CD15N
C1
-10P11D
-10P12D
-10P13D
-10P14D
-10P15D
-12
-10P16D
-10P17D
-10P17D
-10P16D
-10P15D
-10P14D
-10P13D
-10P12D
-10P11D
-7 P9
-7P8
-7P6
-7P4
-7P3
-7P2
-7P1
-21
A5
SECTION AH AH 2-C18
SECTION OF -3 ONLY (NO SCALE)



14
13
12
11
10
SECTION AK-AK 2-E11
(NO SCALE)
-11P18C
-11P17C
-11P16C
-11P15C
-11P14C
-11P12C
-11P13C
-11P11C
-11P10C
-7P9
-7P6
-7P4
-7P3
-7P2
-7P1
-21
OWRS STA 80.00
OWRS STA 70.00
OWRS STA 80.00
-11 DOUBLER
AK 2-F11
AK
-11P10C
-11P18C
-11P16C
-11P17C
-11P10C
-11P11C
-11P12C
-11P13C
11P14C
11P15C
11P16C
11P17C
11P18C
-11P11C
+45°
0°
-45°
90°
-7P7
AG
AG 2-A13
AF
AJ
-7P8
-9P15B
-9P14B
-9P10B
-9P11B
-9P16B
-9P17B
-9P18B
-9P12B
-9P13B
-12
-9P17B
-9P16B
-9P15B
-9P14B
-9P13B
-9P12B
-9P18B
-9P10B
2-A11 AJ
-3
-12
-9P18B
-9P10B
VIEW BB
LOOKING UP AT LOWER
-3 SKIN ASSY LWR.
-7P9
-7P8
-7P6
-7P6
-7P3
-7P2
-7P1
-21
A5 SECTIONAG AG 2-C13
(NO SCALE)
-9P10B
-9P11B
-9P12B
-9P13B
-9P14B
-9P15B
-9P16B
-9P17B
-9P18B
-21
-7P1
-7P2
-7P3
-7P4
-7P6
-7P9
SECTION AJ -AJ 2-B11
(NO SCALE)
A5
-21
SECTION AF AF 2-C9
(NO SCALE)
CODE IDENT NO
DRAWING NO.
LTR
SH
80378
78-002553
A
2

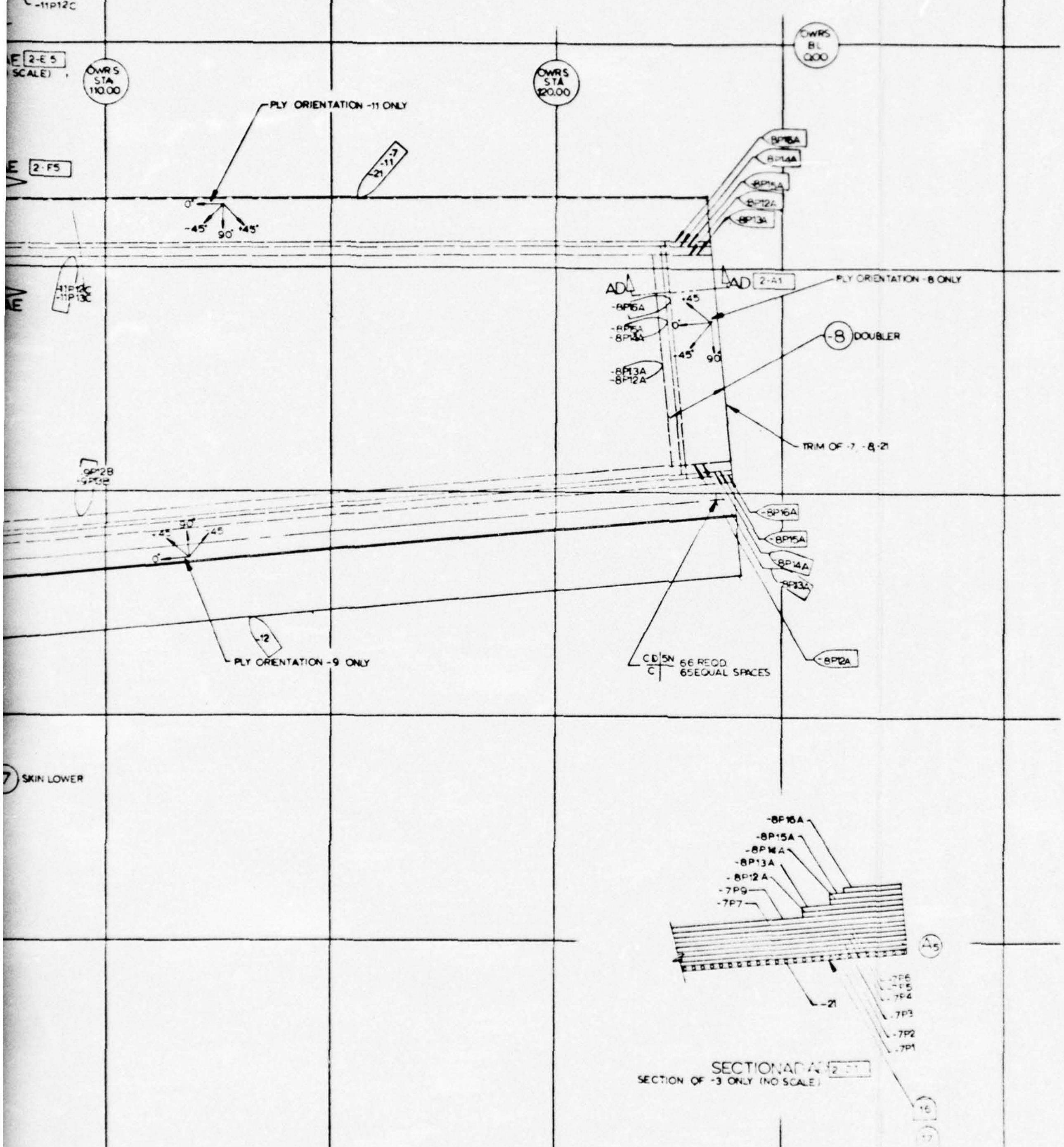


9
8
7
6
5
4
SCREEN -21
SECTION AE AE 2-E5
SECTION OF -3 ONLY (NO SCALE)
OWRS STA 90.00
OWRS STA 100.00
OWRS STA 110.00
AE 2-F5
AE
AF
AF 2-A9
-9 DOUBLER
-12 SEAL
-7 SKIN LOWER
VIEW B B 4-A3
OKING UP AT LOWER SURFACE
SECTION W W 2-C8
SECTION OF -3 ONLY (NO SCALE)
ECTION AF AF 2-C9
(NO SCALE)

PLY ORIENTATION CHART

PLY LAYUP NUMBER

PART NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
-7	0°	0°	+45°	0°	0°	-45°	0°	0°	0°									
-8												+45°	-45°	+45°	-45°	+45°		
-9										+45°	-45°	+45°	-45°	+45°	-45°	-45°	-45°	+45°
-10											-45°	+45°	45°	+45°	45°	-45°	45°	
-11										+45°	-45°	+45°	-45°	+45°	-45°	+45°	-45°	+45°



CODE IDENT NO	DRAWING NO	LTR	SH
80378	78-002553	A	2

REVISIONS

ZONE	LTR	DESCRIPTION	DATE

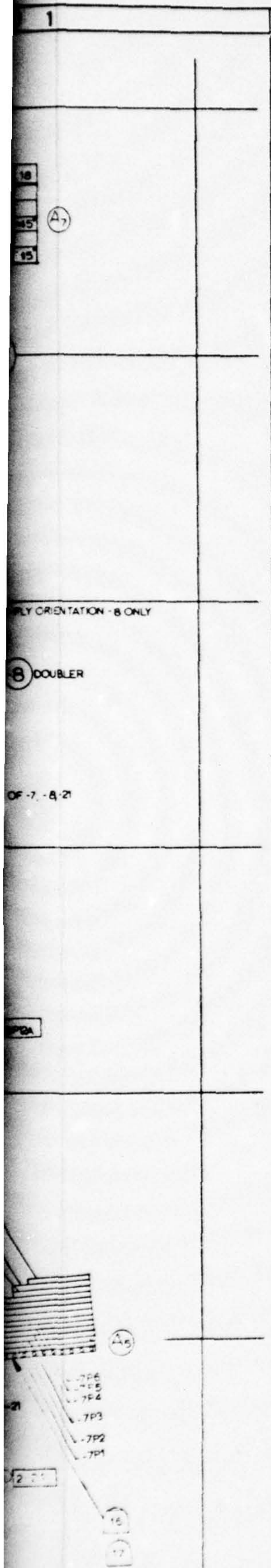
REVISION STATUS OF SHEETS

NONSTANDARD SYMBOLS

INDICATES REFERENCE CALLOUT OF DASH NO. OF THIS DRAWING

INDICATES GENERAL NOTE OF SEPARATE PARTS LIST

INDICATES LIMITATION SEE SEPARATE PARTS LIST



REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASE AUTHORITY 1C281-4		
		1 ADDED A 0° PLY NUMBERED -7P4 TO THE LOWER SKIN		
		2 RENUMBERED FOLLOWING PARTS: (WAS) -7P4, -7P5, -7P7, -7P8 (NOW) -7P5, -7P6, -7P8, -7P9		
		3 DELETED FOLLOWING PARTS: -8P7A, -8P11A, -9P9B, -9P19B, -10P10D, -10P18D, -11P7C, -11P19C		
		4 REVISED TRIM OF DOUBLER PLIES TO DROP OFF TWO EVERY .20 INSTEAD OF ONE EVERY .10		
		5 CHANGED ALL VIEWS AND SECTIONS TO REFLECT THE ABOVE CHANGES		
2F		6 REVISED PLY ORIENTATION CHART TO REFLECT ABOVE CHANGES		
2F		7 INCORPORATED E.O.10261.3 WITH CHANGES TO REFLECT NEW AND REIDENTIFIED PARTS		
		8 ADDED PLY ORIENTATION SYMBOL FOR DOUBLERS -8, -9, -10, -11		
		9 ADDED SECTIONS AJ & AK		

OFFICIAL ENGINEERING RELEASE

REVISION STATUS OF SHEETS

SEE SEPARATE PARTS LIST

NONSTANDARD SYMBOLS

-XXX INDICATES REFERENCE CALLOUT OF DASH NO. OF THIS DRAWING

X INDICATES GENERAL NOTE ON SEPARATE PARTS LIST

INDICATES LIMITATION SEE SEPARATE PARTS LIST

DIMENSIONED FEATURES ARE LINEAR / ANGULAR ±0° 30'

.XX ±.01

TOLERANCES FOR UNDIMENSIONED FEATURES ARE OUTLINE ±.03

CHECKED

GROUP

STRESS

PROJ ENGR J. MADORIN

CUSTOMER

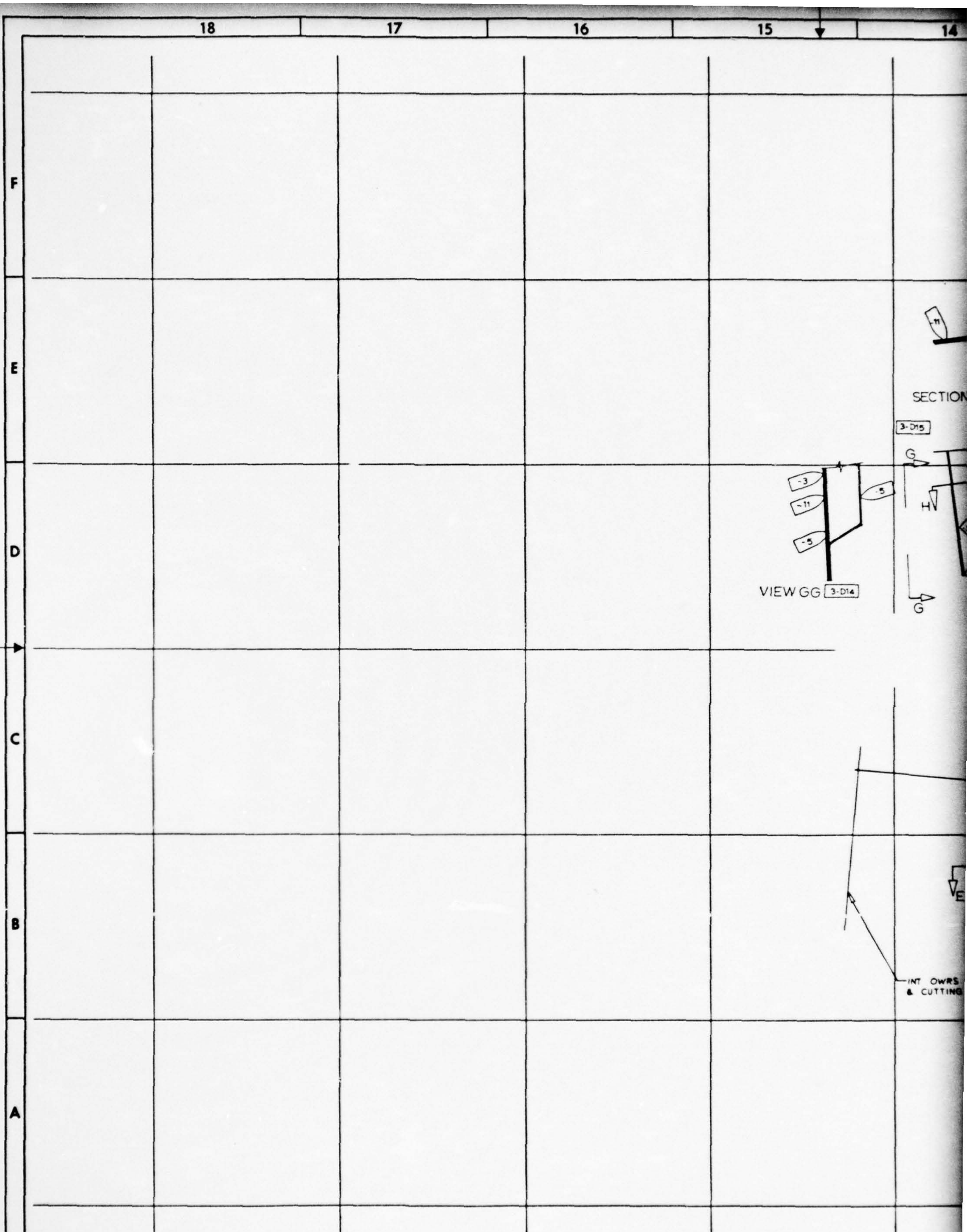
VOUGHT AERONAUTICS COMPANY
LTV AEROSPACE CORPORATION
P.O. BOX 5907 - DALLAS, TEXAS 75222

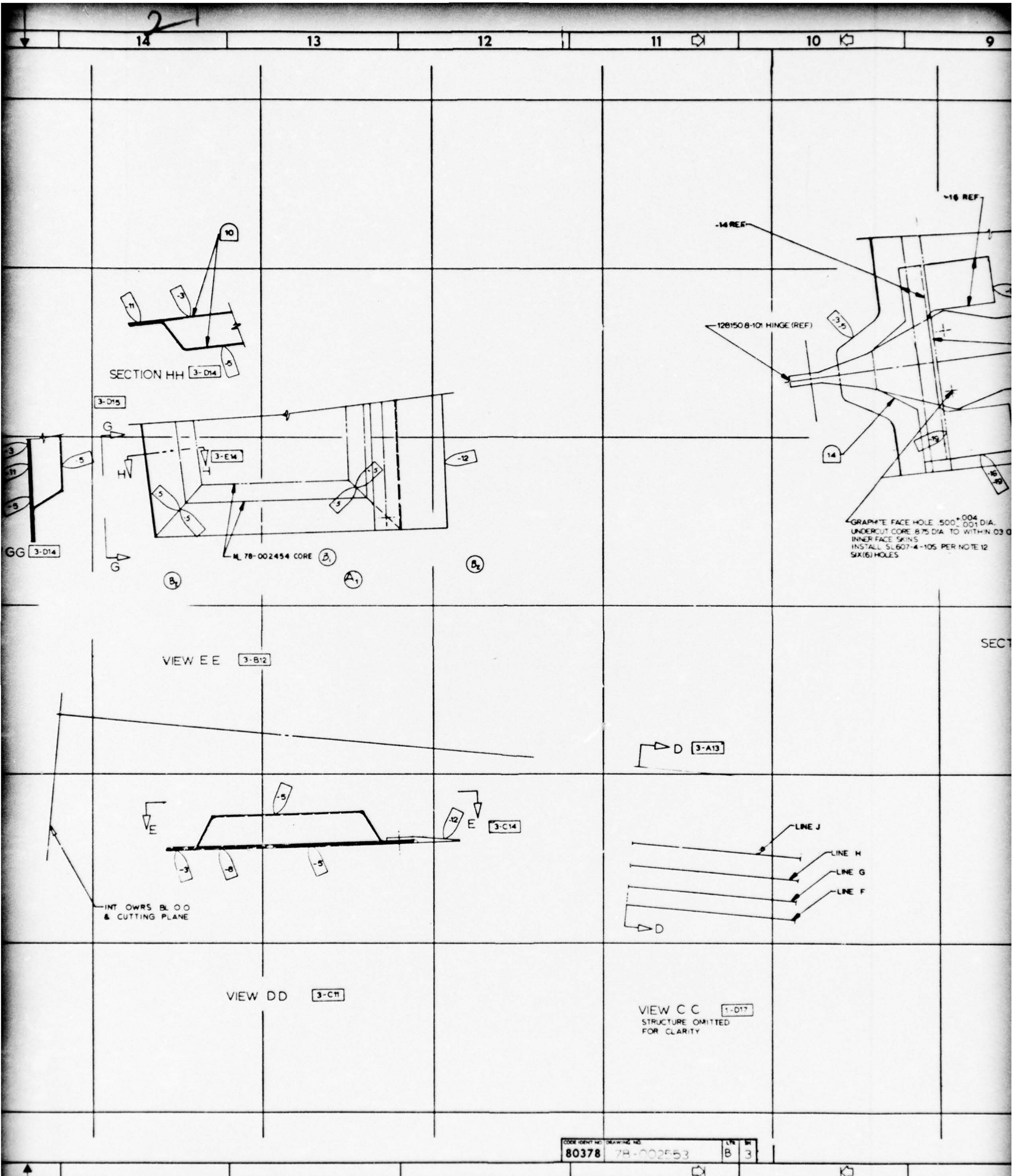
FLAP
S-3A SPOILER LWR. OP
ADVANCED COMPOSITES

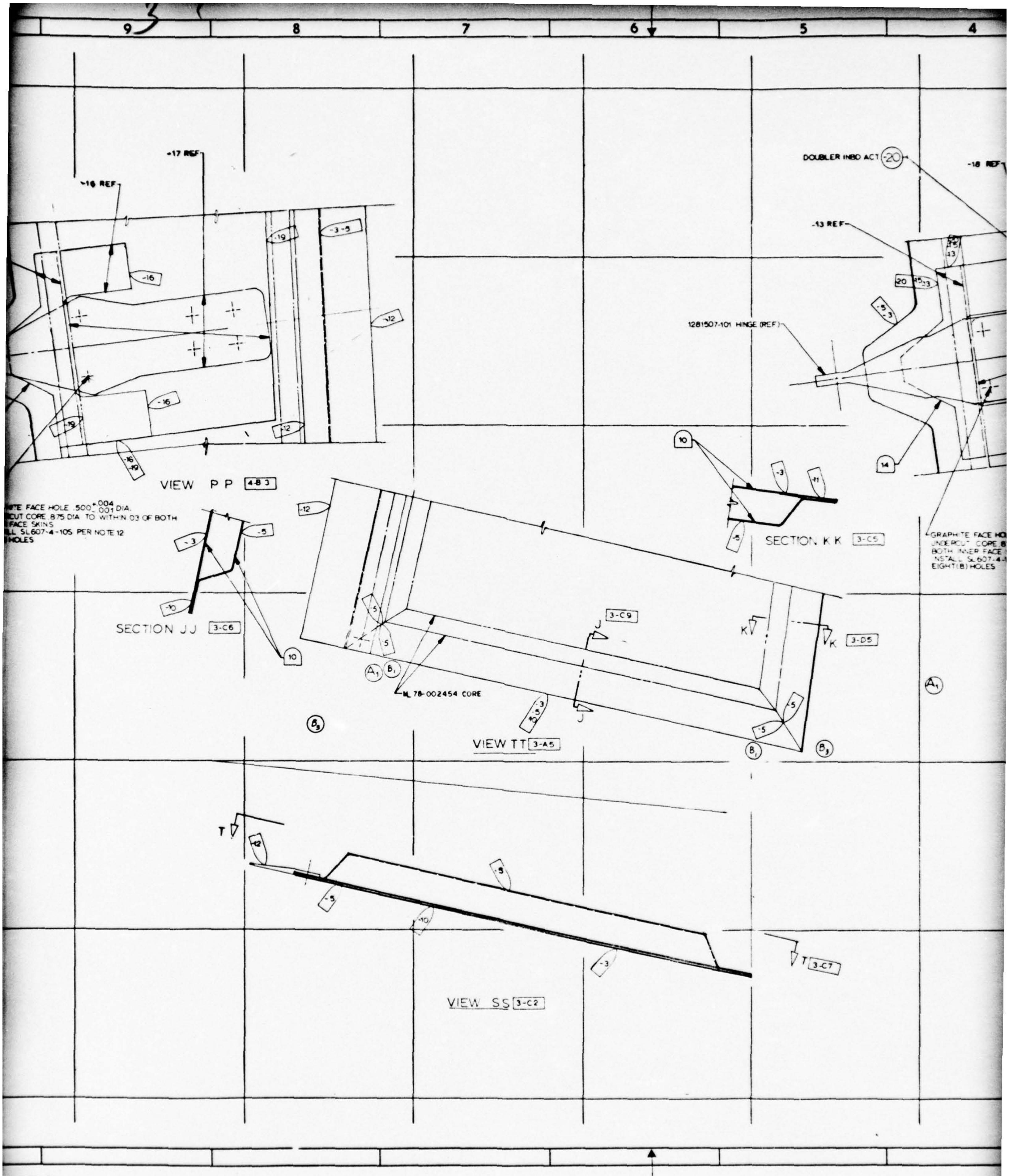
SIZE	CODE IDENT NO	DRAWING NO
J	80378	78-002553

SCALE F | REV LTR A | SHEET 2

FIGURE A-2 (CONT'D) PAGE 9 OF 11

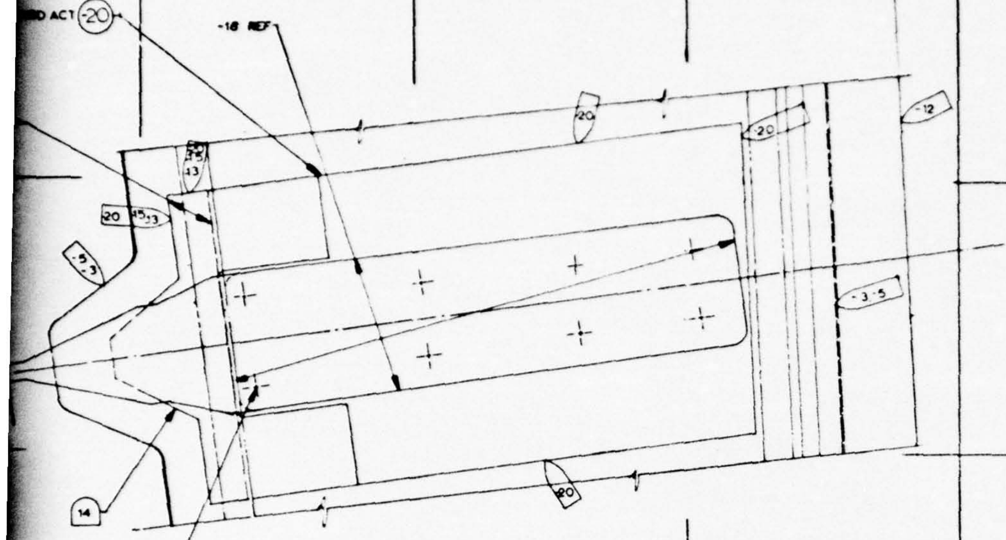

18
17
16
15
14
F
E
D
C
B
A
-11
SECTION
3-D15
G
H
-3
-11
-5
-5
VIEW GG 3-D14
G
E
INT OWRS
& CUTTING


14
13
12
11
10
9
10
-3
-11
SECTION HH 3-D14
-5
3-D15
G
-3
-11
-5
-5
H
3-E14
-12
-5
-5
-5
-5
GG 3-D14
G
78-002454 CORE B_1
A_1
B_2
B_2
VIEW E E 3-B12
-5
-12
E
E 3-C14
-3
-8
-5
INT OWRS BL O O
& CUTTING PLANE
VIEW DD 3-C11
D 3-A13
LINE J
LINE H
LINE G
LINE F
D
VIEW C C 1-D17
STRUCTURE OMITTED
FOR CLARITY
-16 REF
-14 REF
1281508-101 HINGE (REF)
-3
-5
14
-19
-16
-19
GRAPHITE FACE HOLE .500 +.004 -.001 DIA.
UNDERCUT CORE .875 DIA TO WITHIN .03 O
INNER FACE SKINS
INSTALL SL607-4-105 PER NOTE 12
SIX(6) HOLES
SECT
CODE IDENT NO
DRAWING NO.
LTR
SH
80378
78-002553
B
3



9
8
7
6
5
4
-17 REF
-16 REF
DOUBLER INBD ACT -20
-18 REF
-13 REF
1281507-101 HINGE (REF)
VIEW PP 4-B3
ITE FACE HOLE .500 +.004 -.001 DIA.
CUT CORE .875 DIA TO WITHIN .03 OF BOTH
FACE SKINS
LL SL607-4-105 PER NOTE 12
HOLES
SECTION JJ 3-C6
SECTION KK 3-C5
GRAPHITE FACE HO
UNDERCUT CORE .8
BOTH INNER FACE
INSTALL SL607-4-
EIGHT (8) HOLES
ML 78-002454 CORE
VIEW TT 3-A5
3-C9
3-D5
VIEW SS 3-C2
3-C7

4 | 3 | 2 | 1



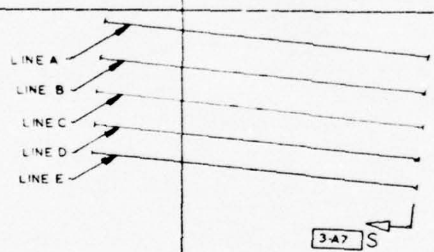
VIEW RR 4-D7

GRAPHITE FACE HOLE .500 $^{+.004}_{-.001}$ DIA.
UNDERCUT CORE .875 DIA. TO WITHIN .03 OF BOTH INNER FACE SKINS
INSTALL SL607-4-10S PER NOTE 12
EIGHT (8) HOLES

3-C5

3-D5

A_1



VIEW FF 1-A2
STRUCTURE OMITTED FOR CLARITY

CODE IDENT NO	DRAWING NO	LTR	SH
80378	78-002552	B	3

5

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
5C 14D	A	RELEASE AUTHORITY 10161.4 1. REVISED VIEW TO REFLECT ADDITIONAL PLIES AND REIDENTIFIED PLIES		DWG BY GROUP STR MFGR&D PROJ
CB CS D14 D12 D14 D12 C8 C5	B	RELEASE AUTHORITY 10261.6 1. REVISED CORNER TRIM OF -5 & ADDED "M OF 78-002554 CORE" 2. REMOVED "TRIM OF -5P1, -5P2, -5P3, -5P4, -5P5, -5P6, -5P8" 3. REMOVED "TRIM OF -5P1, -5P2, -5P3, -5P5, -5P7, -5P8"		DWG BY GROUP STR MFG R&D PROJ

OFFICIAL ENGINEERING RELEASE

REVISION STATUS OF SHEETS — SHEET 1 2 3 4 5 6 7 8 9 10

SEE SEPARATE PARTS LIST

NONSTANDARD SYMBOLS

—XXX INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING

X INDICATES GENERAL NOTE ON SEPARATE PARTS LIST

⊘ INDICATES LIMITATION SEE SEPARATE PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

TOLERANCES FOR DIMENSIONED FEATURES ARE
LINEAR .XXX = ± ; .XX = ± .04 ; .X = ± ; ANGULAR ± 0° 30'

TOLERANCES FOR UNDIMENSIONED FEATURES ARE
OUTLINE ± .03 ANGLE ± 30' FROM CENTERLINE OF SCRIBED LINES

DESIGN GROUP NAME: COMPOSITES

CONTR NO / PREPARED / CHECKED / GROUP: MADORIN 9-9-73 / STRESS / PROJ ENGR

CUSTOMER

VOUGHT AERONAUTICS COMPANY
LTV AEROSPACE CORPORATION
P.O. BOX 5907 DALLAS, TEXAS 75222

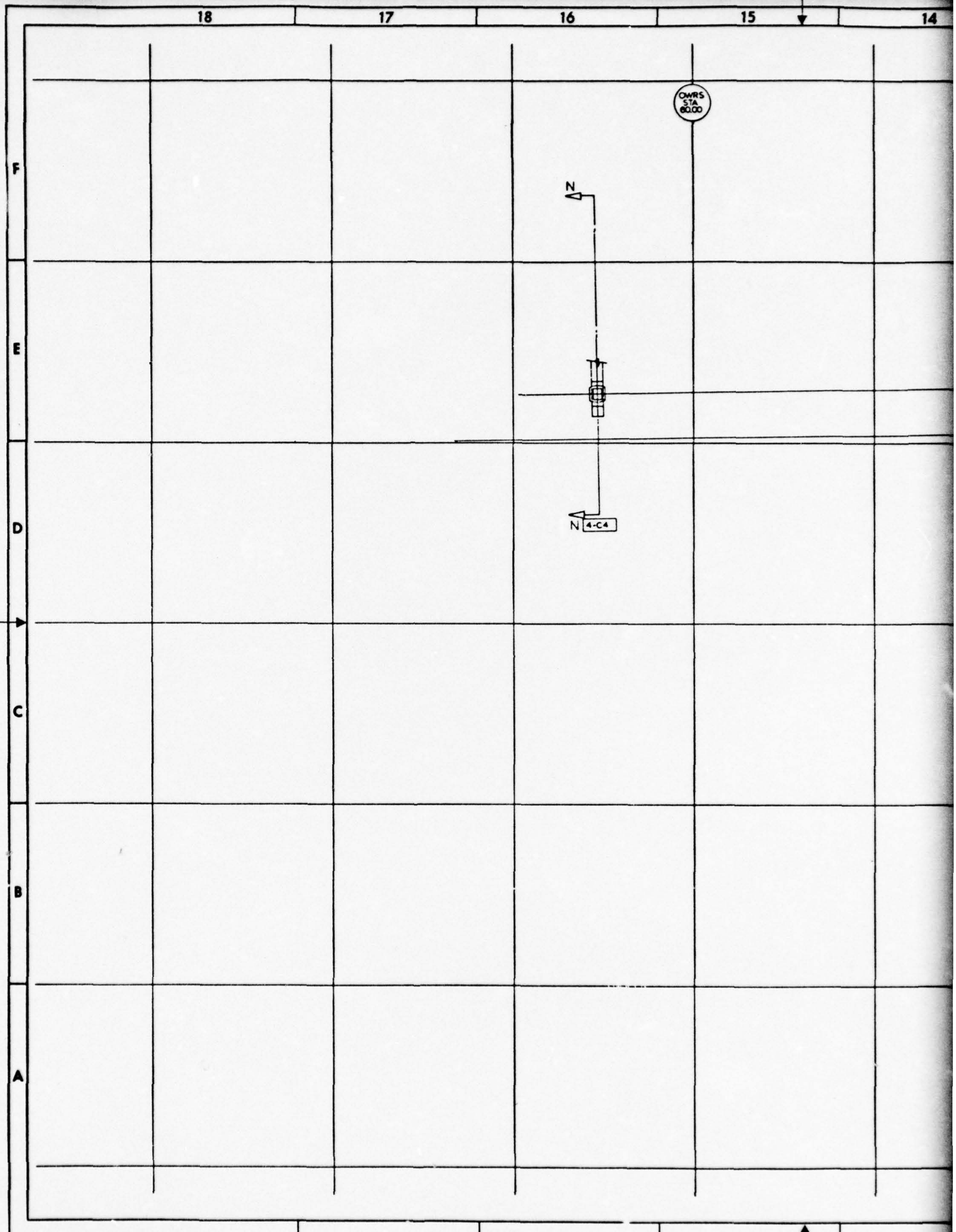
FLAP
S-3A SPOILER LWR OP
ADVANCED COMPOSITES

SIZE J | CODE IDENT NO 80378 | DRAWING NO 78-002553

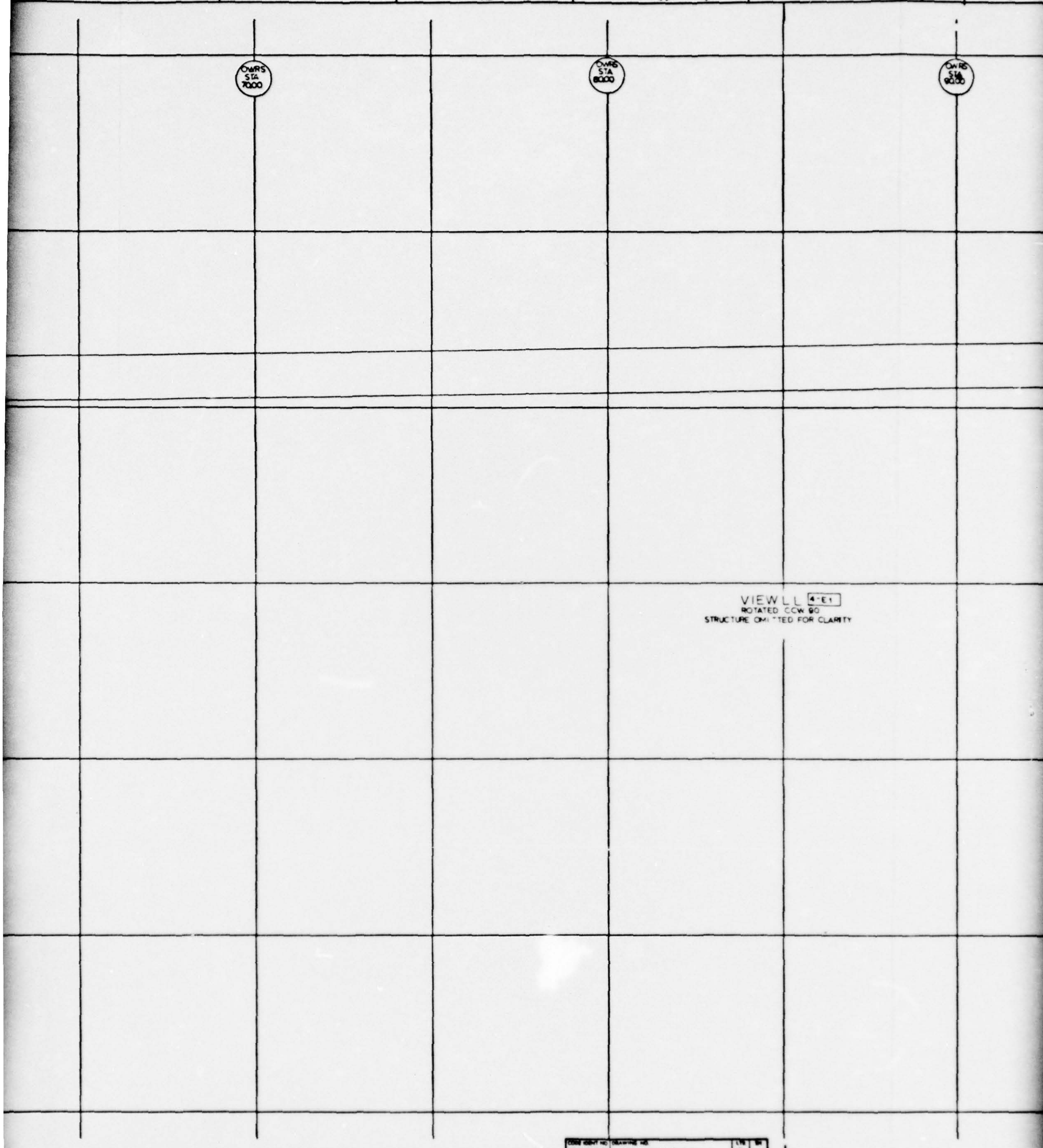
SCALE 1:1 | REV LTR B | SHEET 3

F E D C B A

FIGURE A-2 (CONT'D) PAGE 10 OF 11


18
17
16
15
14
F
E
D
C
B
A
OWRS
STA
60.00
N
N
4-C4

14	13	12	11	10	9



CODE IDENT NO	DRAWING NO	LTR	SH
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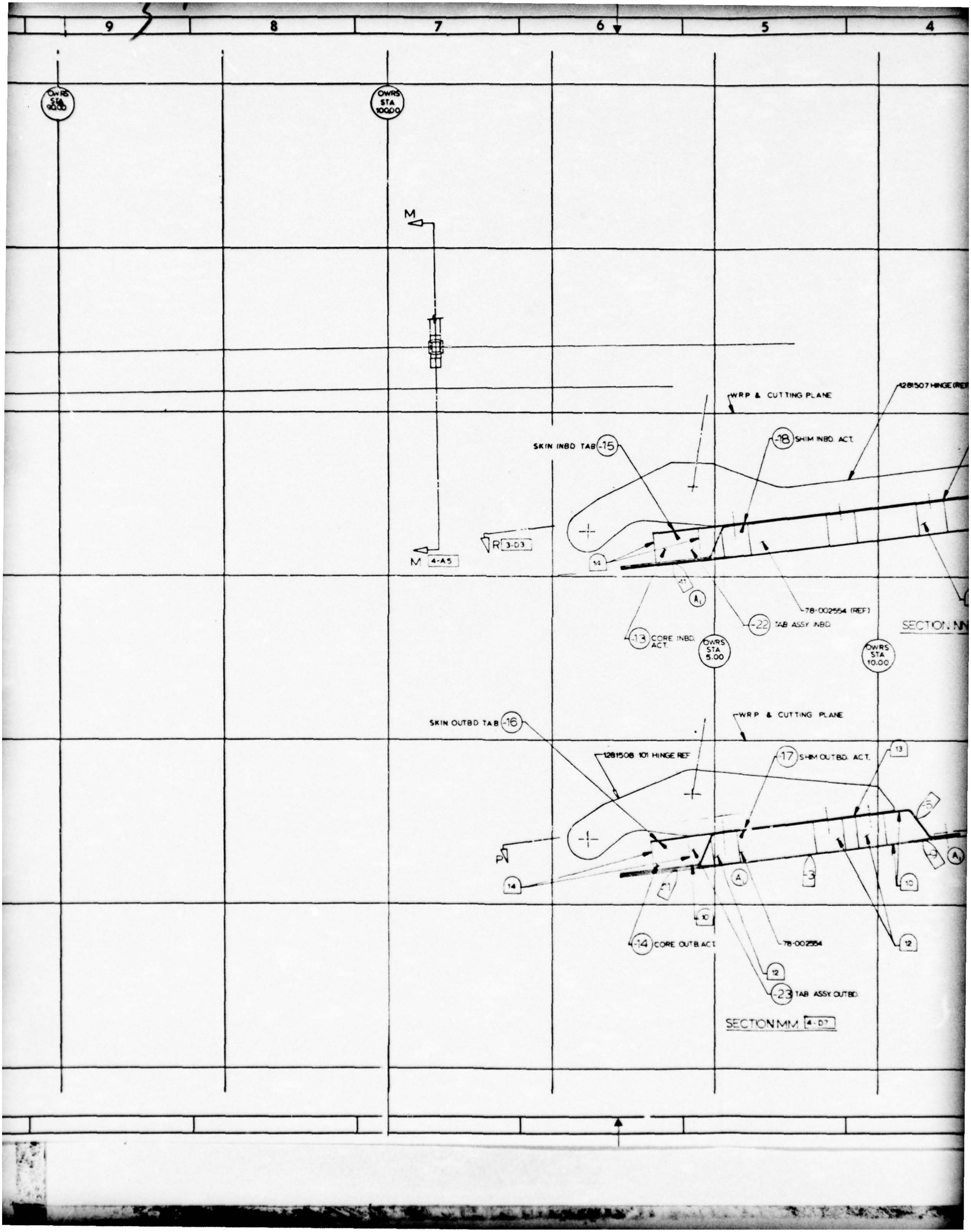
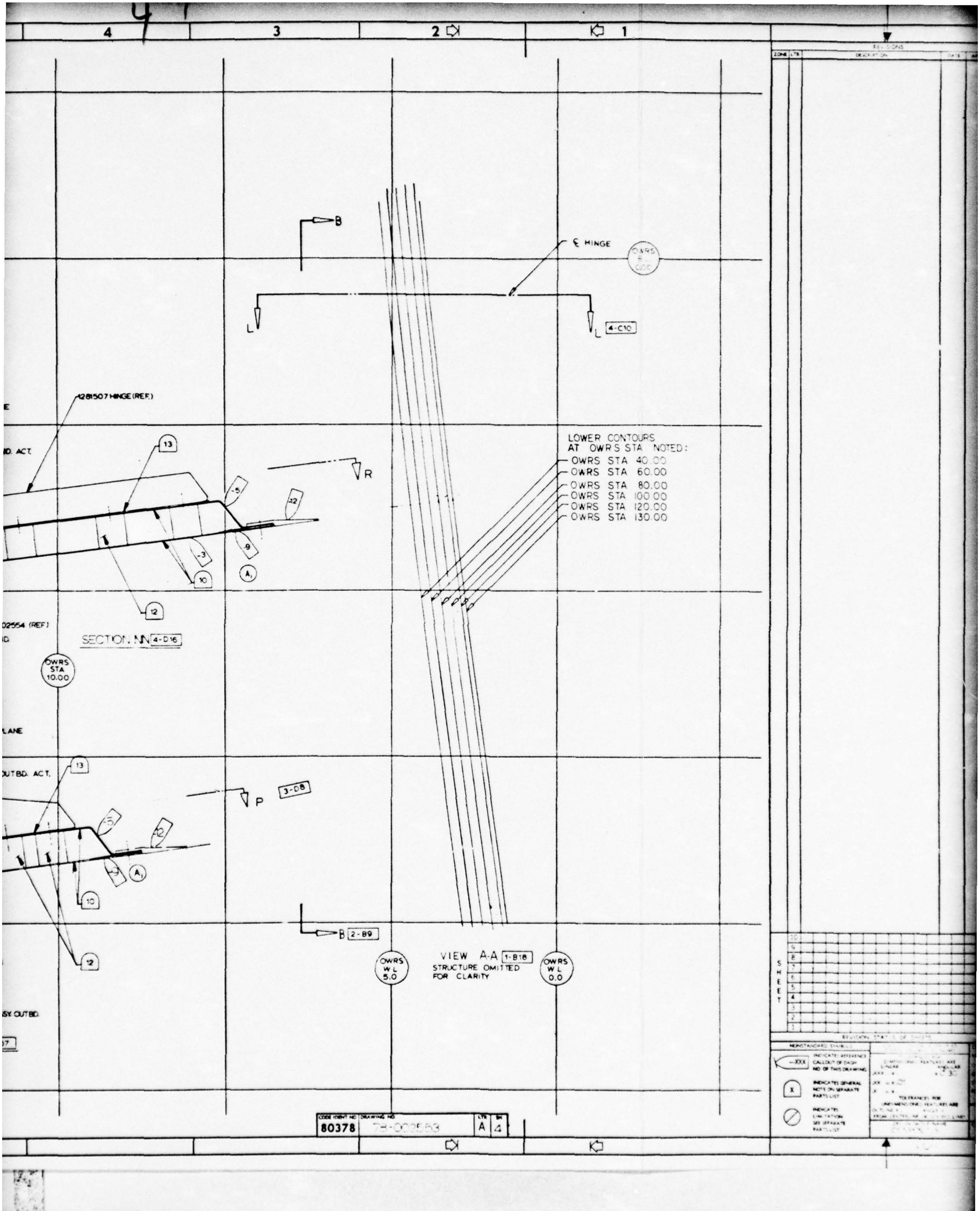


9
8
7
6
5
4
OWRS STA 90.00
OWRS STA 100.00
M
M 4-A5
R 3-D3
WRP & CUTTING PLANE
1281507 HINGE (REF)
SKIN INBD TAB -15
-18 SHIM INBD. ACT.
14
-11
A1
78-002554 (REF)
-22 TAB ASSY INBD.
-13 CORE INBD. ACT.
SECTION NN
OWRS STA 5.00
OWRS STA 10.00
SKIN OUTBD TAB -16
WRP & CUTTING PLANE
1281508 101 HINGE REF
-17 SHIM OUTBD. ACT.
13
-5
P
14
-1
A1
-3
-9
A1
10
10
-14 CORE OUTB. ACT
78-002554
12
12
-23 TAB ASSY. OUTBD.
SECTION MM 4-D7


4
3
2
1
℄ HINGE
OWRS B 0.00
L
L 4-C10
B
1281507 HINGE (REF)
BD. ACT.
13
-5
42
R
-3
-9
10
A1
12
02554 (REF)
BD.
SECTION NN 4-D16
OWRS STA 10.00
LOWER CONTOURS
AT OWRS STA NOTED:
OWRS STA 40.00
OWRS STA 60.00
OWRS STA 80.00
OWRS STA 100.00
OWRS STA 120.00
OWRS STA 130.00
LANE
UTBD. ACT.
P 3-D8
B 2-B9
OWRS W L 5.0
VIEW A-A 1-B18
STRUCTURE OMITTED FOR CLARITY
OWRS W L 0.0
SY. OUTBD.
REVISIONS
ZONE
LTR
DESCRIPTION
DATE
SHEET
10
9
8
7
6
5
4
3
2
1
REVISION STATUS OF SHEETS
NONSTANDARD SYMBOLS
INDICATES REFERENCE CALLOUT OF DASH NO OF THIS DRAWING
INDICATES GENERAL NOTE ON SEPARATE PARTS LIST
INDICATES LIMITATION SEE SEPARATE PARTS LIST
TOLERANCES FOR
CODE IDENT NO
80378
DRAWING NO
78-002563
LTR
A
SH
4

5

REVISIONS

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASE AUTHORITY 10261.6		DWG BY G. MARTINEZ
D5,6 B3,4		1. REVISED M_L OF CORE IN SECT. N-N & M-M TO AGREE WITH SHEET 1		GROUP ST. MFG ENG PROJ

F

E

D

C

B

A

SHEET 10 9 8 7 6 5 4 3 2 1

REVISION STATUS OF SHEETS

SEE SEPARATE PARTS LIST

NONSTANDARD SYMBOLS

-XXX INDICATES REFERENCE CALLOUT OF DASH NO. OF THIS DRAWING

(X) INDICATES GENERAL NOTE ON SEPARATE PARTS LIST

⊘ INDICATES LIMITATION SEE SEPARATE PARTS LIST

DIMENSIONAL FEATURES ARE LINEAR ANGULAR

.XXX ± .X ± 0°30'

.XX ± .01

.X ± .X

TOLERANCES FOR UNDIMENSIONED FEATURES ARE

CONTR NO.

PREPARED

CHECKED

GROUP

STRESS

PROJ ENGR

CUSTOMER

VOUGHT AERONAUTICS COMPANY

LTV AEROSPACE CORPORATION

P.O. BOX 5907 DALLAS, TEXAS 75222

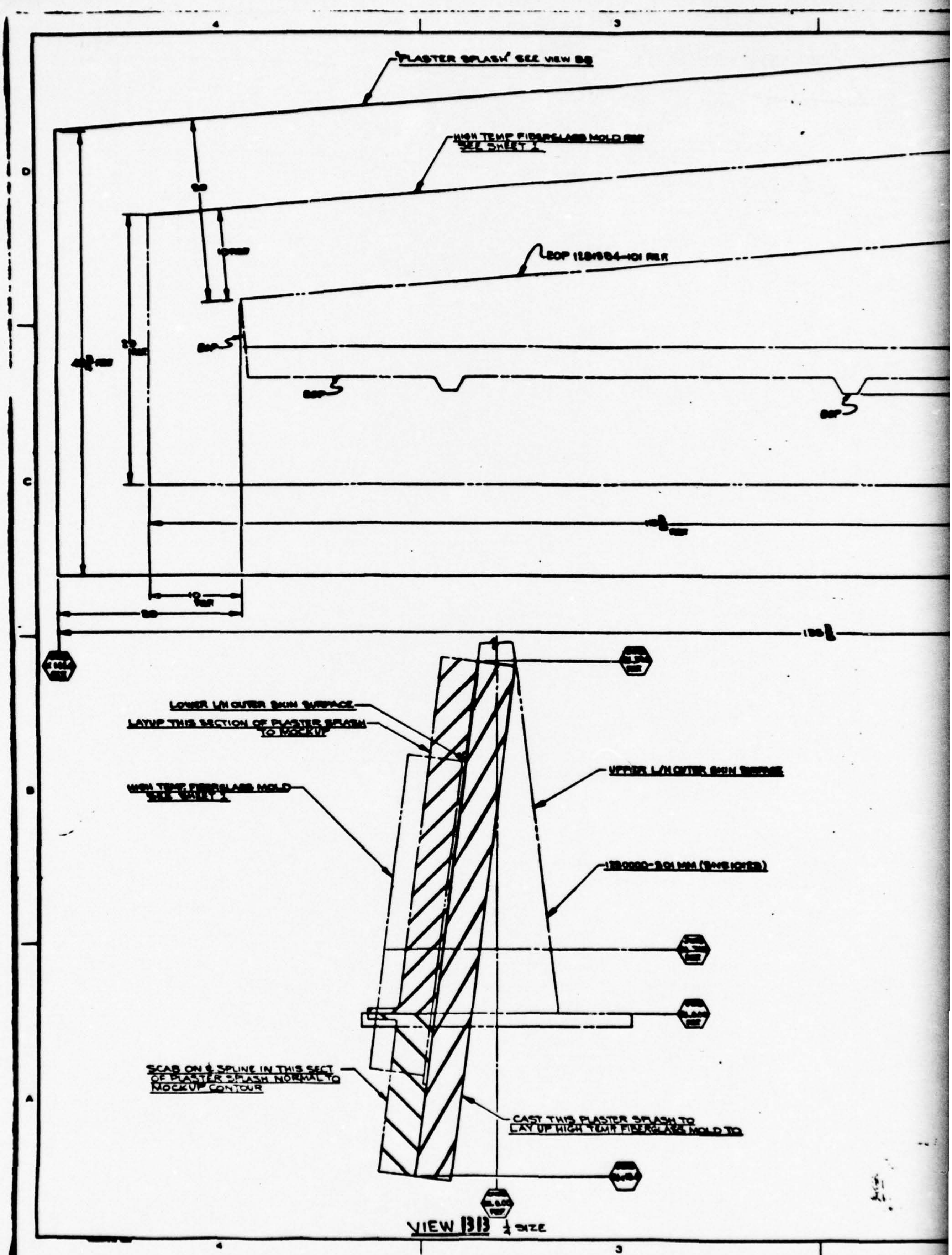
FLAP

S-3A SPOILER LWR. O.P. ASSY COMPOSITES

SIZE J | CODE IDENT NO. 80378 | DRAWING NO. 78-002553

SCALE | REV LTR A | SHEET 4

FIGURE A-2 (CONT'D) PAGE 11 OF 11


"PLASTER SPLASH" SEE VIEW BB
HIGH TEMP FIBERGLASS MOLD REF
SEE SHEET 1
LOWER L/H OUTER SKIN SURFACE
LAYUP THIS SECTION OF PLASTER SPLASH TO MOCKUP
HIGH TEMP FIBERGLASS MOLD SEE SHEET 1
UPPER L/H OUTER SKIN SURFACE
SCAB ON & SPLINE IN THIS SECT OF PLASTER SPLASH NORMAL TO MOCKUP CONTOUR
CAST THIS PLASTER SPLASH TO LAY UP HIGH TEMP FIBERGLASS MOLD TO
VIEW BB ½ SIZE

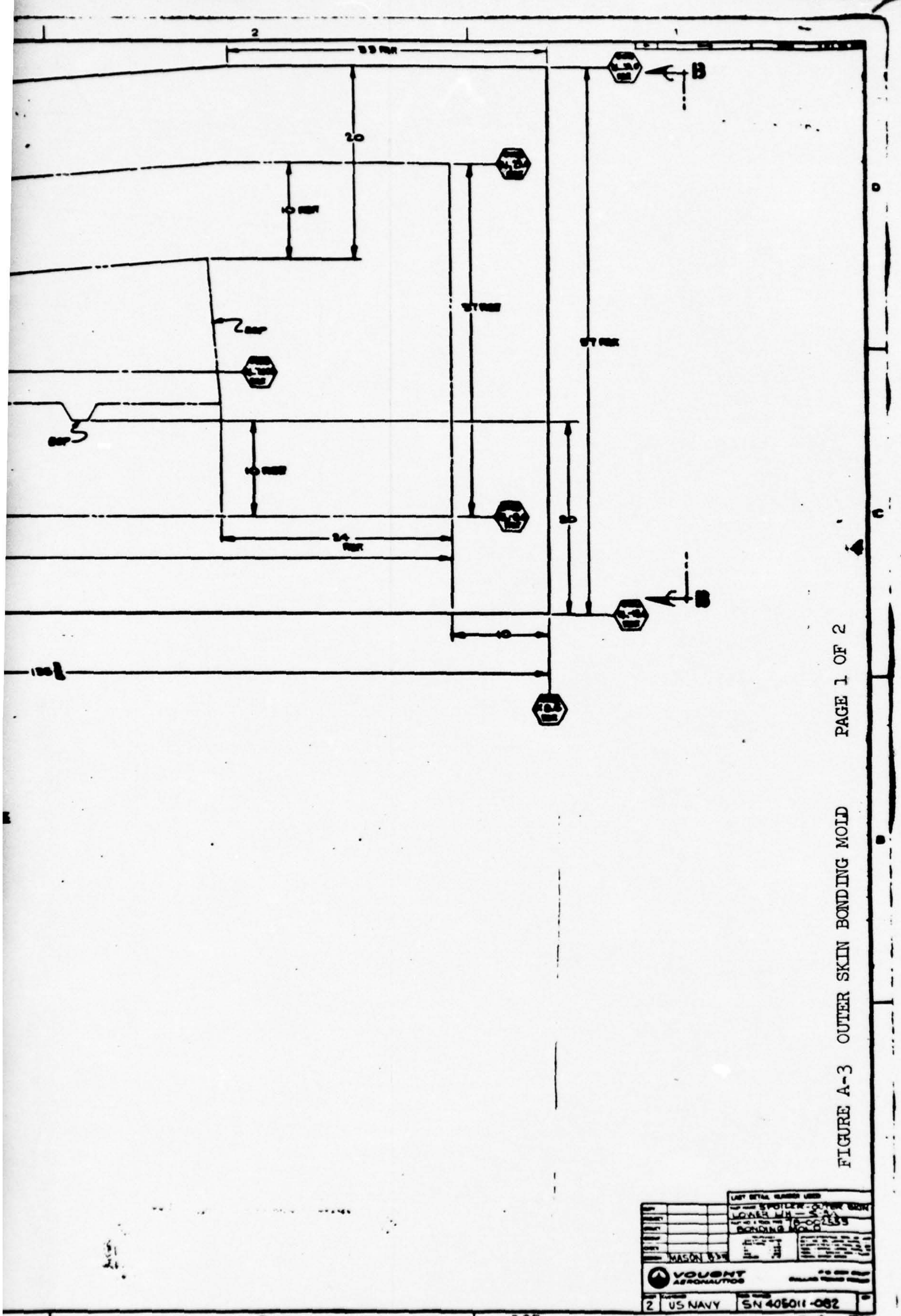
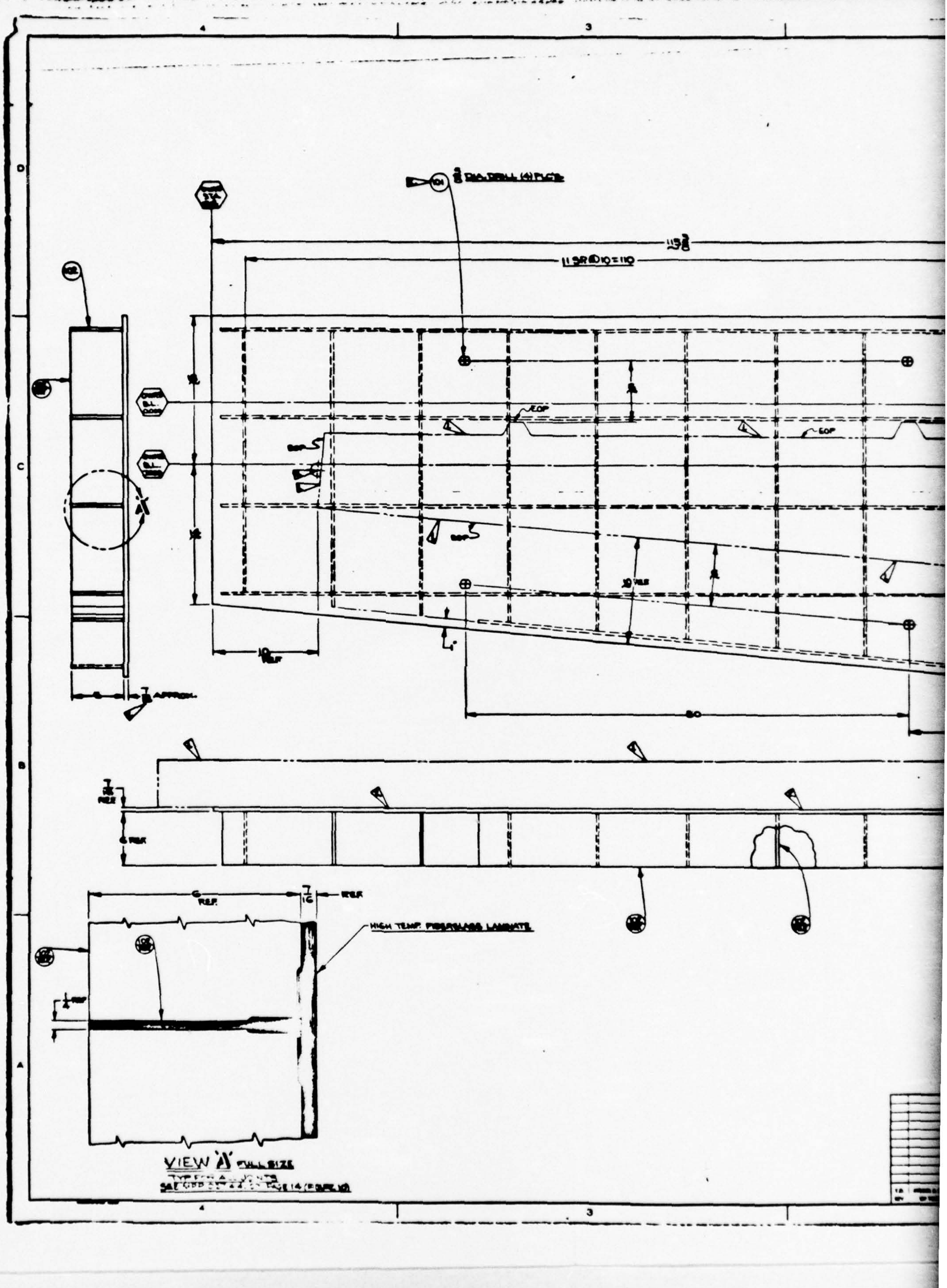


FIGURE A-3 OUTER SKIN BONDING MOLD PAGE 1 OF 2


4
3
D
C
B
A
3/8 DIA. DRILL (4) PLCS.
113 3/8
11 SP @ 10 = 110
EOP
10 REF
80
7/16 REF
6 REF
APPROX.
HIGH TEMP. FIBERGLASS LAMINATE
VIEW 'A' FULL SIZE

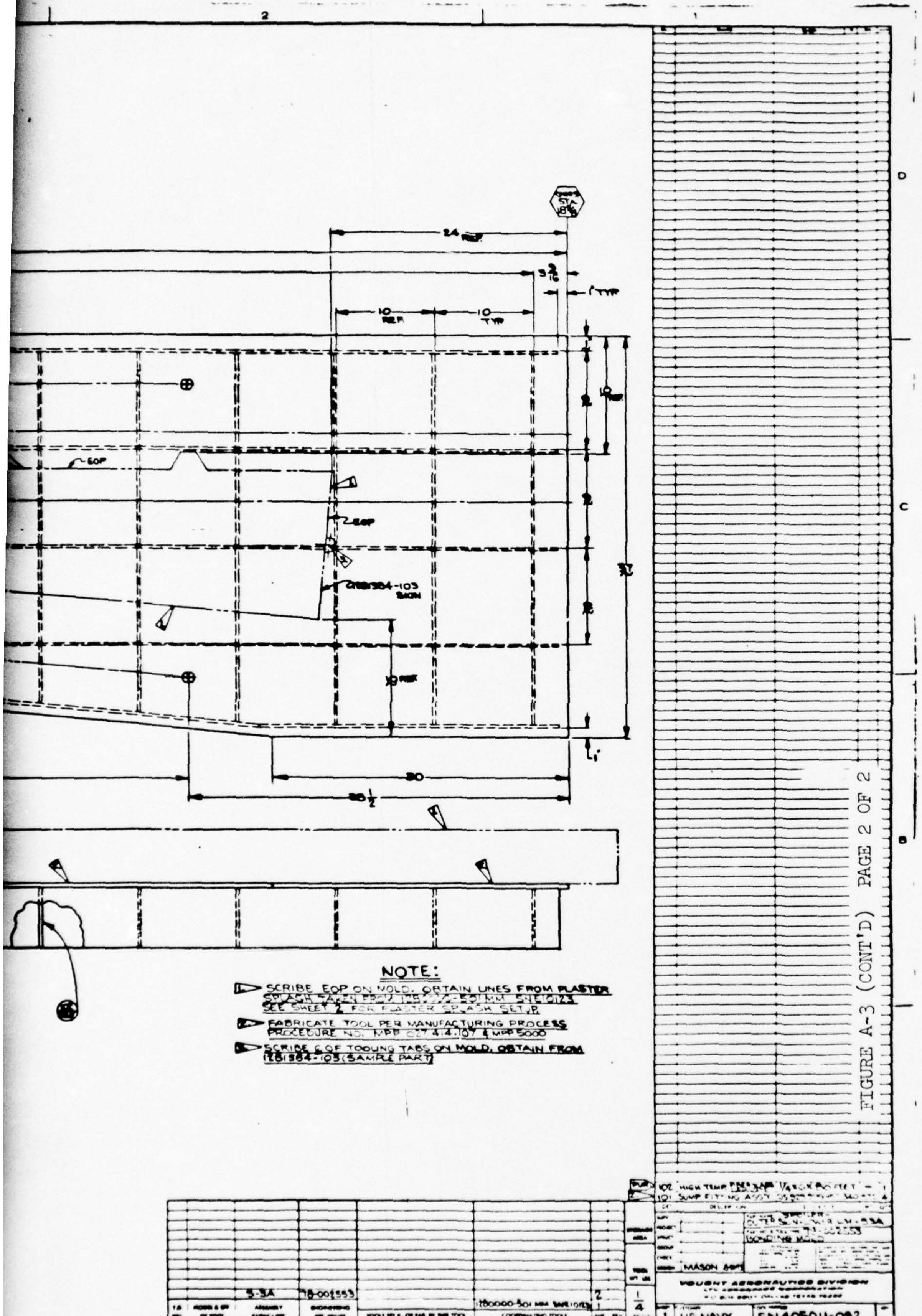


FIGURE A-3 (CONT'D) PAGE 2 OF 2

APPENDIX B

This Appendix contains the documentation relating to the component testing under this contract and presents the following information.

A) Static Test Plan - Report No. 2-53440/3R-10108
   Rev A, 2/27/74

B) Summary Report #1 Static Test dtd 30 May 1974

C) Selected Strain gage information - Static Test #1
   Run #3, #5, #6, and #7 (7 pages)

D) Summary Report #2 Static Test

E) Selected Strain gage information - Static Test #2
   Run #3, #6, #7B, and #9 (9 pages)

F) Summary Report #3 Static Test

G) Selected strain gage information - Static Test #3
   Run #3, #6, #7, and #9C (9 pages)

H) Fatigue Test Plan - Report No. 2-53440/3R-10109
   Rev A, 6/17/74

I) Summary Report - Fatigue Test

Report No. 2-53440/3R-10108
Rev. A. 2/27/74

12 Dec. 1973

Static Test Plan S-3A
Composite Spoiler

Prepared Under
Contract N62269-73-C-0610

BY
Vought Systems Division
LTV Aerospace Corporation
FOR
Naval Air Development Center
Warminister, Pa.

PREPARED BY:

J E Littlefield

J. E. Littlefield
Engineer Specialist - Structures

APPROVED BY:

W. A. Poindexter

W. A. Poindexter
Supervisor, Structures Tech.

REVIEWED BY:

O. E. Dhonau

O. E. Dhonau
Senior Specialist - Structures Tech.

APPROVED BY:

Leon E. Boswell

Leon E. Boswell
Supervisor, Structures

STATIC TEST PLAN S3A ADVANCED COMPOSITES SPOILER

PURPOSE:

The purpose of this test is to verify the design capability of the lower left hand graphite/epoxy spoiler for the S-3A aircraft. Three spoilers will be tested to failure by the method described in the following paragraphs.

DESCRIPTION OF TEST:

Two (2) load conditions will be investigated; the opening load (tension on lower surface) and the closing (failing) load (compression on lower surface). The opening load will be 115% of design limit and failing (closing) load will be 150% of design limit based on data provided in Figure B-1. Test data will be acquired from five (5) rosette strain gages and eighteen (18) deflection devices as shown in Figure B-2.

REQUIREMENT:

This test plan is required per contract N62269-73-C-0610.

TEST SPECIMEN:

The test specimen will consist of a graphite S3A lower spoiler assembly as defined by DWG78-002553 Flap S3A Spoiler, LWR. O.P. Advanced Composite. The specimen will be supported at the actuator hinge fitting thru the mounting holes provided as shown in Figure B-3.

TEST CONDITIONS:

Maximum spoiler hinge moments occur as a function of surface rotation and airspeed as given in Figure B-1. Table B-I gives the hinge moments and positions for the spoiler static test opening and closing condition. Spoiler spanwise unit running hinge moment curves are presented in Figure B-4.

TEST SETUP:

The specimens will be installed in the Test jig as shown in Figure B-2 and B-3. Air loads on the spoiler will be simulated by applying test loads through tension pads. Figure B-3 shows location of pads and applied load at each location, at maximum test loads.

TEST PROCEDURES:

Loads will be applied in increments of no greater than 20 percent design limit load to 100 percent limit load, and in increments of no greater than 10 percent design limit load from 100 to 150 percent design limit load. The structure will be loaded to 115% of design limit opening load (tension) and to failure for the closing load (compression).

Strains will be reduced and plotted during static tests as a check on predicted stress values. Deflection data will be checked during all tests. If a change in deflection rate or strain rate occurs, the above loading increments may be altered to obtain sufficiently small subsequent increments to determine if this change is linear or curvilinear.

MEASUREMENT OF STRUCTURAL DEFLECTIONS:

Structural deflections at spoiler and jig support points will be measured primarily by displacement devices supported by independent structures. The accuracy will be ±.02 inches deflection or better.

METHODS OF LOAD APPLICATION:

All loads will be applied to simulate as nearly as practicable the actual loads on the test article. The loads will be introduced into the structure in such a manner that secondary stresses will not be induced at load application points due to structural deflections during tests.

Loads will be transmitted by rubber backed tension pads bonded to the surfaces. The applied static test loads will be supplied to pads by means of hydraulic jacks.

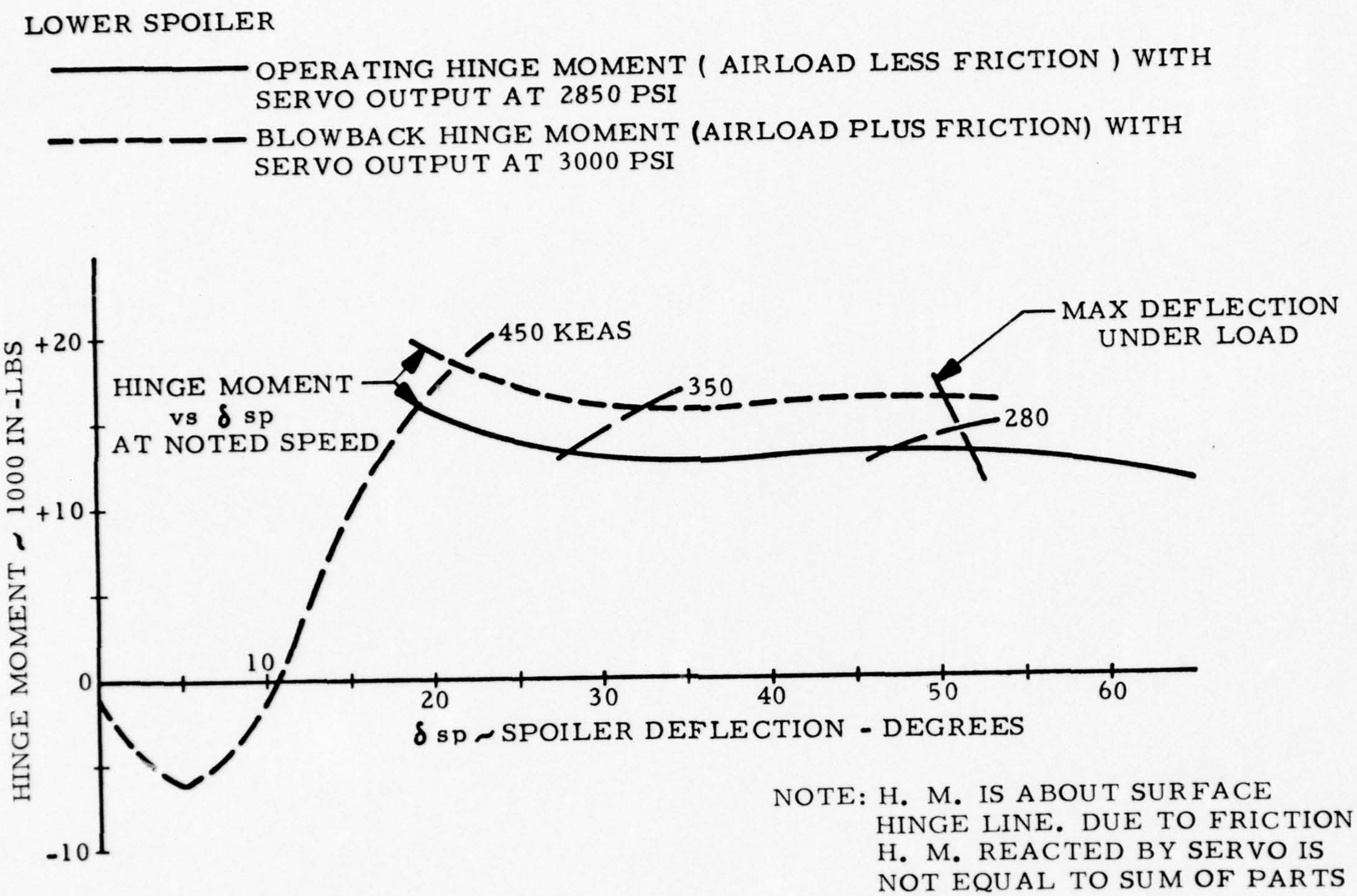
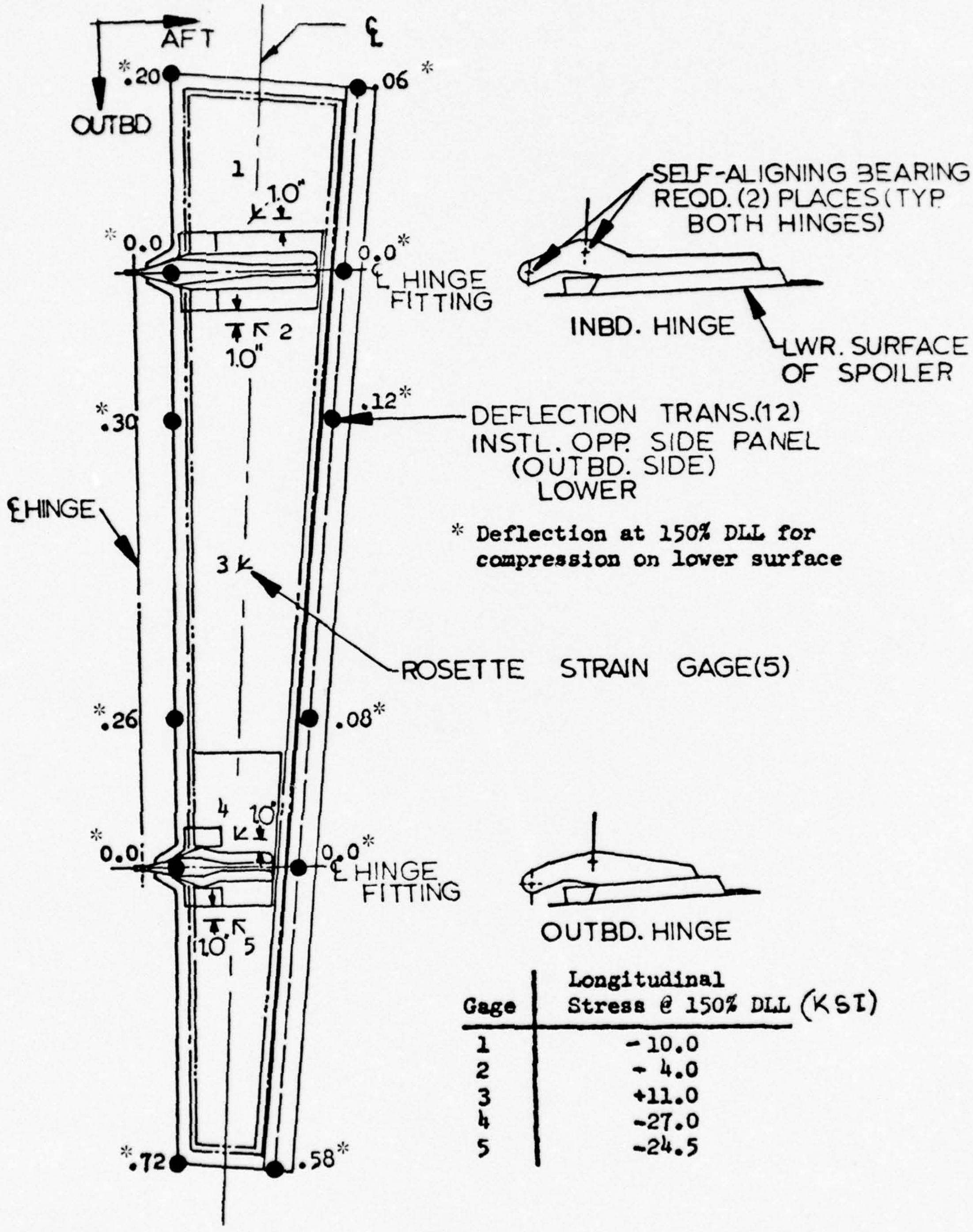


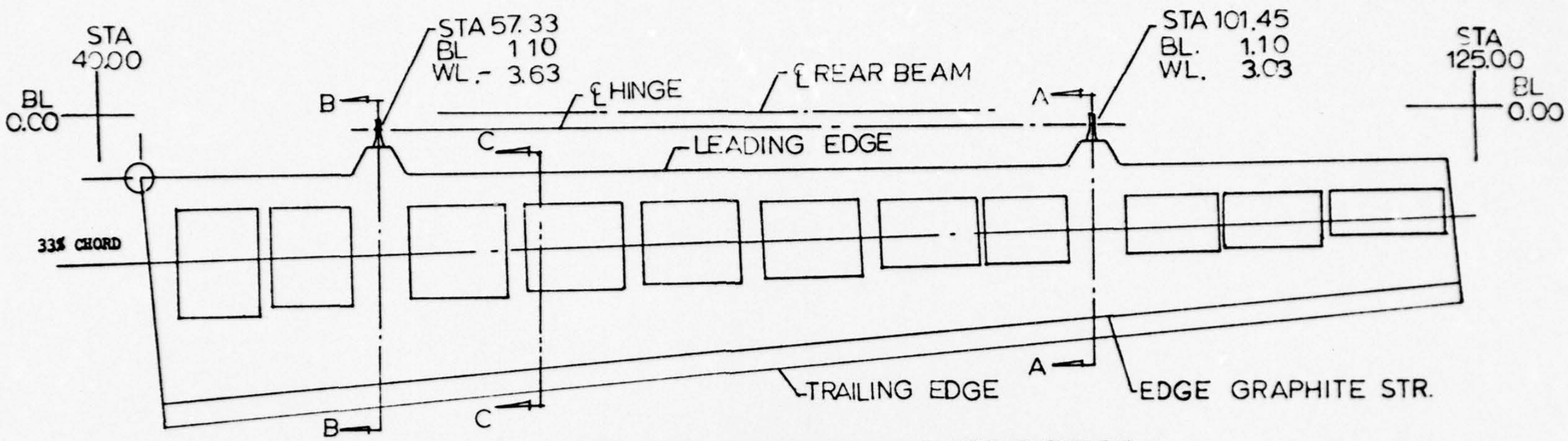
FIGURE B-1 SPOILER HINGE MOMENTS



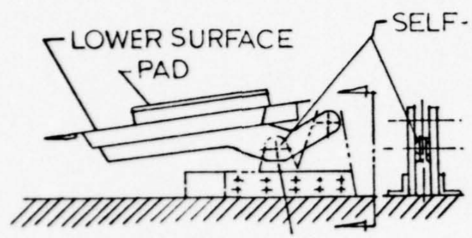
* Deflection at 150% DLL for compression on lower surface

Gage	Longitudinal Stress @ 150% DLL (KSI)
1	-10.0
2	- 4.0
3	+11.0
4	-27.0
5	-24.5

FIGURE B-2 DEFLECTION AND STRAIN GAGE LOCATIONS



LOWER SPOILER (LOOKING AT OUTER SURFACE)



SECTION BB

SECTION CC

SECTION AA

PAD NO.	PAD SIZE	PAD LOCATION X	PAD LOCATION Y	UPPER SURFACE PAD LOAD LBS (150%)	PAD PRESS PSI	LOWER SURFACE PAD LOAD LBS (115%)	PAD PRESS PSI
1	5 x 6.4	7.38	8.20	540	16.9	133	4.16
2	5 x 6.2	12.90	7.80	424	13.7	104	3.37
3	6 x 5.8	22.32	7.45	420	12.1	104	2.98
4	6 x 5.3	29.56	6.90	420	13.2	104	3.27
5	6 x 4.9	36.79	6.50	380	12.9	94	3.19
6	6 x 4.6	44.03	6.20	380	13.8	94	3.41
7	6 x 4.3	51.26	5.80	350	13.5	87	3.37
8	5.3 x 4.0	57.00	5.68	270	12.74	67	3.16
9	5.6 x 3.6	66.50	5.15	250	12.40	62	3.07
10	6 x 3.1	72.97	4.70	312	16.8	77	4.13
11	5.8 x 2.8	79.25	4.33	312	19.2	77	4.74

*Pad locations are given by locating the aft-otbd corner of pads.
X & Y are measured ∥ and ⊥ to spoiler leading edge beginning at fwd-inbd surface corner.

NOTES:

1. Pads located ∥ and ⊥ to spoiler leading edge.
2. Measurements are positive otbd and aft.
3. All measurements are to be made on skin outside surface.
4. Pad pulloffs are to be located at the geometric center of each pad.
5. Pad pulloffs located on spoiler 33% chord (for engineering reference only).
6. Loads shown are maximum.

FIGURE B-3 LOWER L. H. SPOILER STATIC TEST SET-UP AND LOAD REQUIREMENTS

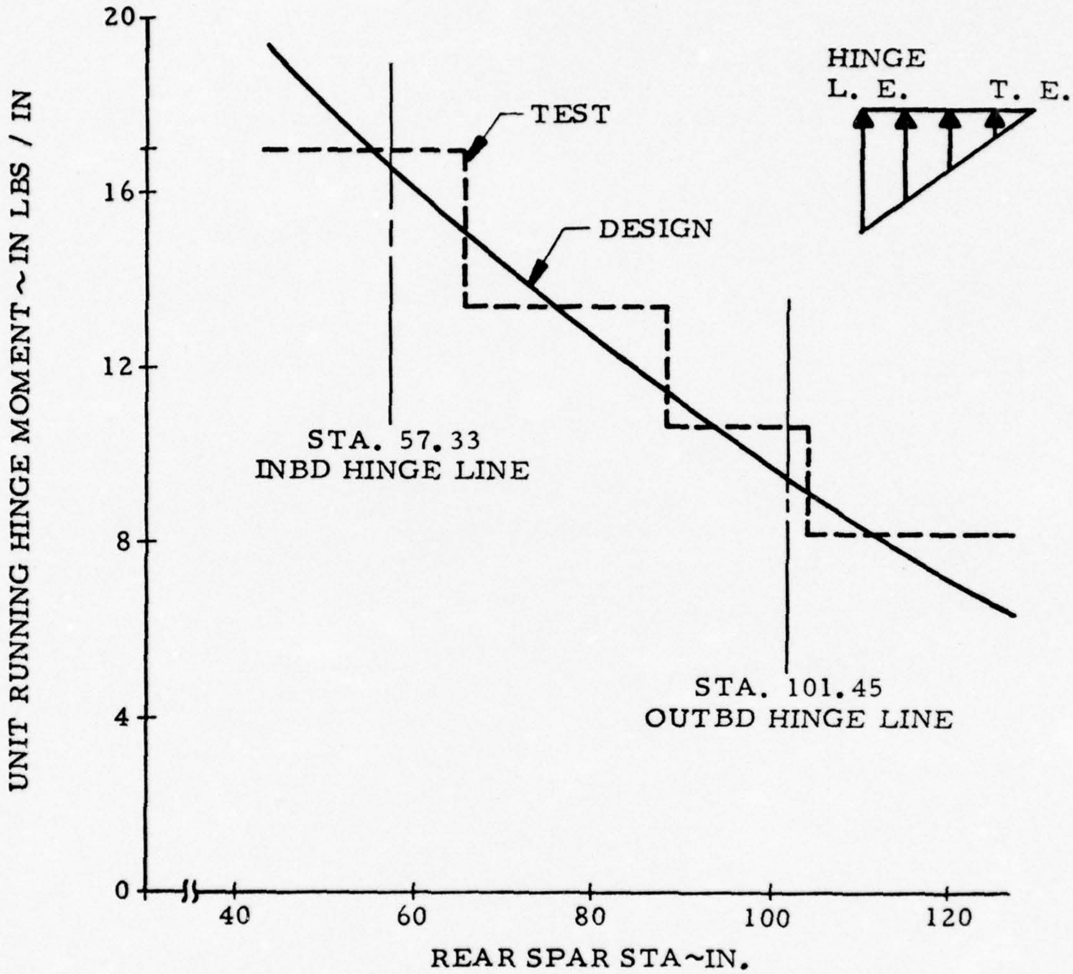


FIGURE B-4 S-3A COMPOSITE SPOILER SPANWISE RUNNING LOAD FOR A TOTAL SURFACE HINGE MOMENT OF 1000 IN - LBS APPLIED (STATIC CONDITION)

TABLE B-I TEST LOADS AND HINGE MOMENTS

PAD LOAD CONDITION	SPOILER POSITION	AIR SPEED	TEST LOAD (LB)	TEST H.M. (IN-LB*)	% (LIMIT)
COMPRESSION	18°	450 KN	4,058	27,900	150
TENSION	5°	450 KN	1,003	6,900	115

*Limit Hinge moment obtained from figure B-1 and increased 24% due to system friction.

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PENNSYLVANIA 18974

3033
30 May 1974

SUMMARY REPORT ON STATIC TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 1

Ref: (a) LTV Report 2-53443/3R-3139, "S-3A Graphite/Epoxy Spoiler Development Program," dtd Jan 1974
(b) LTV Report 2-53440/3R-10108, "Static Test Plan S-3A Composite Spoiler," Revised 27 Feb 1974

Figure: B-5 Photograph No. CAD-18382-4-74--Spoiler loaded at 150 percent DLL
B-6 Photograph No. CAD-18384-4-74--Spoiler loaded at 177 percent DLL
B-7 Photograph No. CAD-18380-4-74--Spoiler loaded at 260 percent DLL
B-8 Photograph No. CAD-18386-B-4-74-- Failure of spoiler at 300 percent DLL

1. The spoiler consists of a graphite/epoxy (G/E) outer skin, a glass-reinforced-plastic honeycomb core, a pan-shaped G/E inner skin, and two production metal hinge fittings attached to the inner surface through inserts in the core. The overall dimensions are 80.7 inches by 15.2 inches inboard tapering to 8.6 inches outboard. A detailed description of the construction is given in reference (a).

2. The spoiler was tested statically in two conditions--the opening condition and the closing condition. Although the closing condition is the critical condition, the opening condition was run to substantiate the spoiler performance for tension loads in the areas of the hinges. The test loads are shown in reference (b). The loading sequence was as follows:

a. Apply 40 percent design limit load (DLL) in opening and closing conditions to check set-up.

b. Apply 100 percent DLL opening load and check test-theory correlation.

c. Apply 115 percent DLL opening load and check test-theory correlation.

d. Apply 100 percent DLL closing load and check test-theory correlation.

e. Apply 150 percent DLL closing load and check test-theory correlation.

f. Apply 177 percent DLL closing load and check test-theory correlation.

g. Apply closing load to failure.

Loads were applied in 20 percent increments up to 100 percent DLL and thereafter, in 10 percent increments. The run to 177 percent DLL was to obtain data for possible new load criteria resulting from button-down of the upper outboard spoiler.

3. The spoiler was installed in the test fixture at the hinges. The distributed airloads were introduced into the structure using tension pads bonded to the surface. The loads for the opening condition were applied to the outer surface (up in the subsequent photographs); loads for the closing condition were applied to the inner surface (down in the subsequent photographs).

4. The spoiler was loaded through the test sequence of paragraph 2 uneventfully. The critical strains and deflections were checked after each run and showed acceptable correlation with the predicted values. The deflection at the outboard tip was less than that of the metal spoiler at the same load. Figures B-5, B-6, and B-7 show the spoiler deflection for the closing condition at several load levels. Loading was continued in 10 percent increments until failure. Failure occurred suddenly at 300 percent DLL with no prior audible sound emanations. Failure occurred at the edge of a doubler outboard of the outboard hinge fitting. The failure is shown in figure B-8.

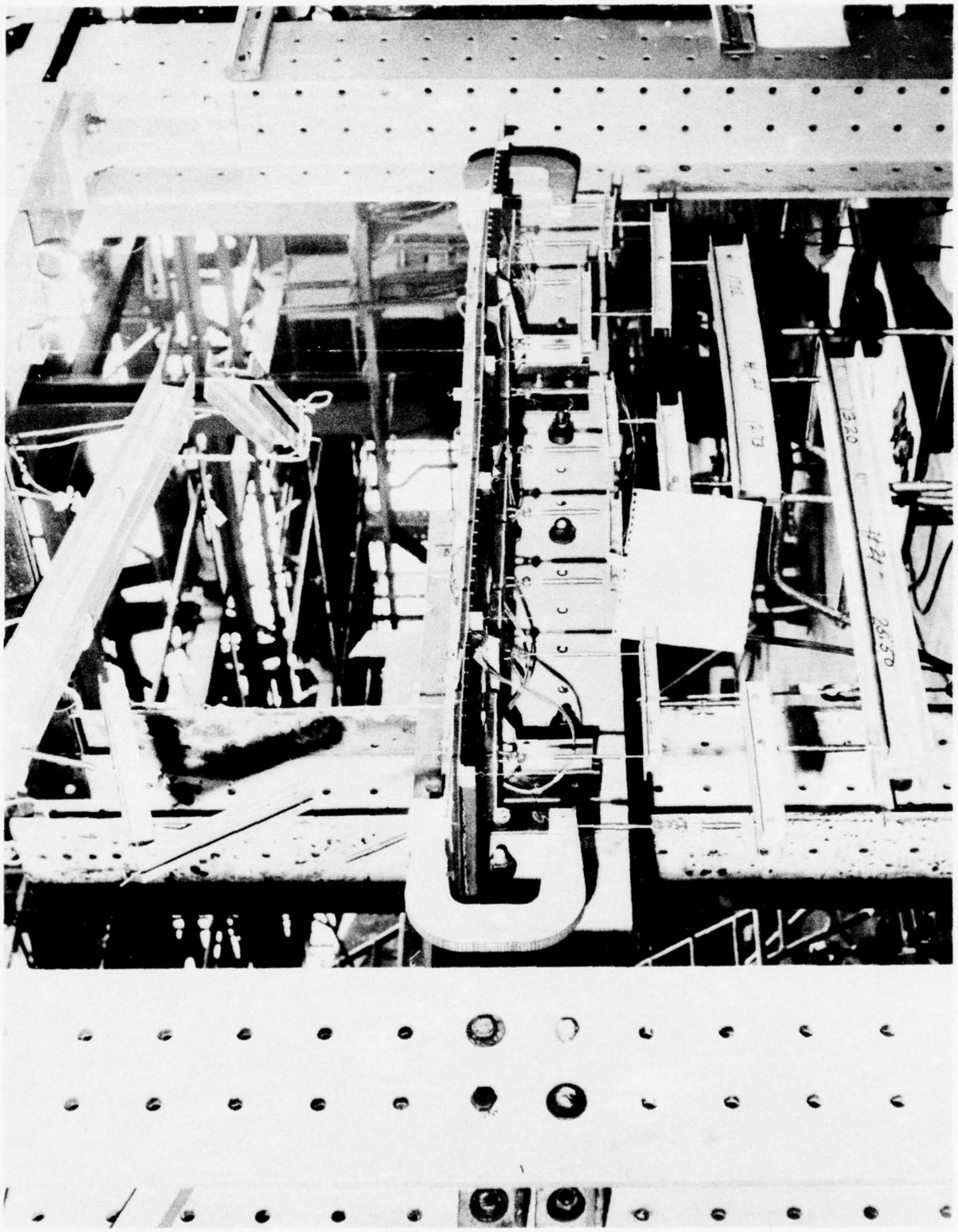


FIGURE B-5 SPOILER LOADED AT 150 PERCENT DLL

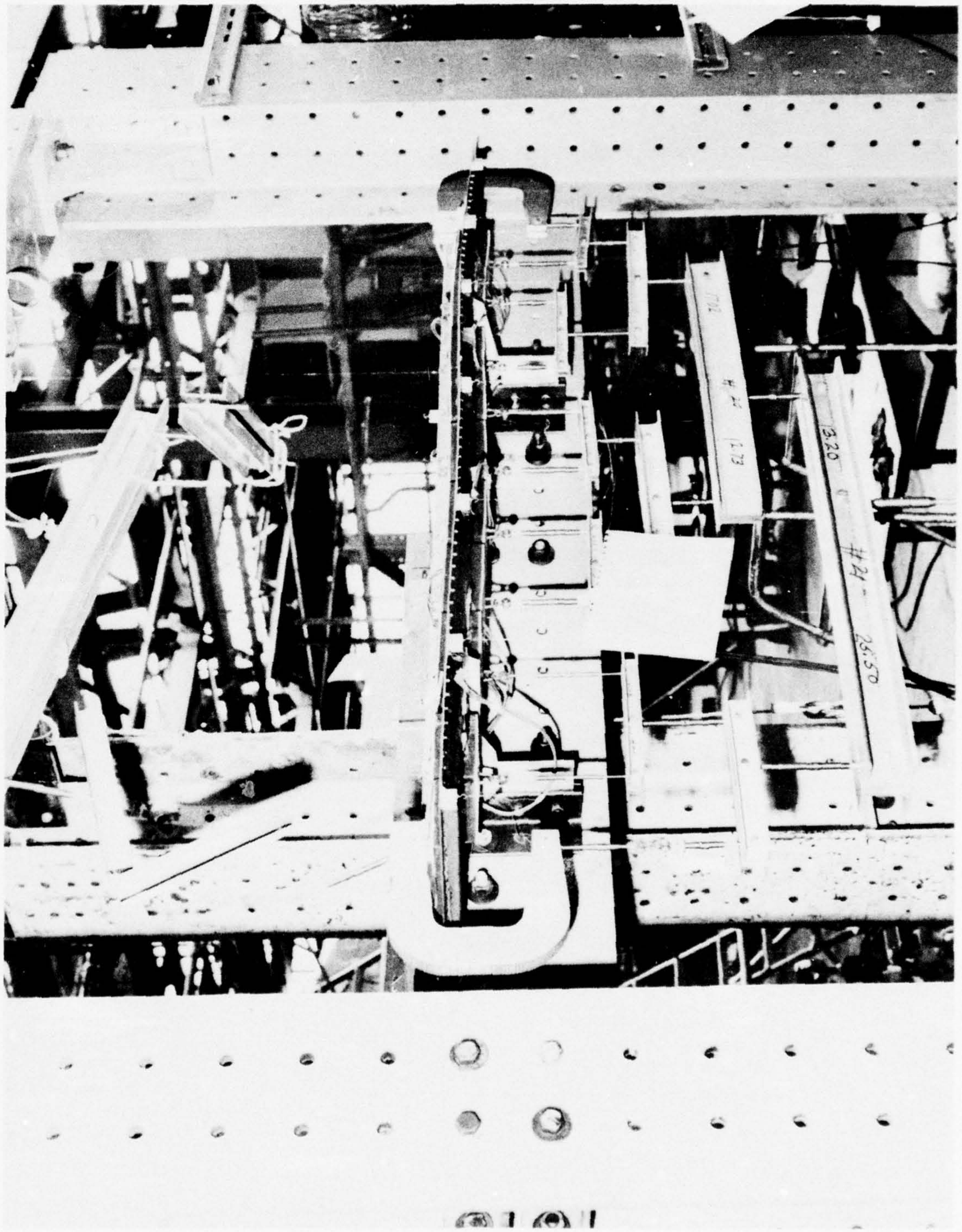


FIGURE B-6 SPOILER LOADED AT 177 PERCENT DLL

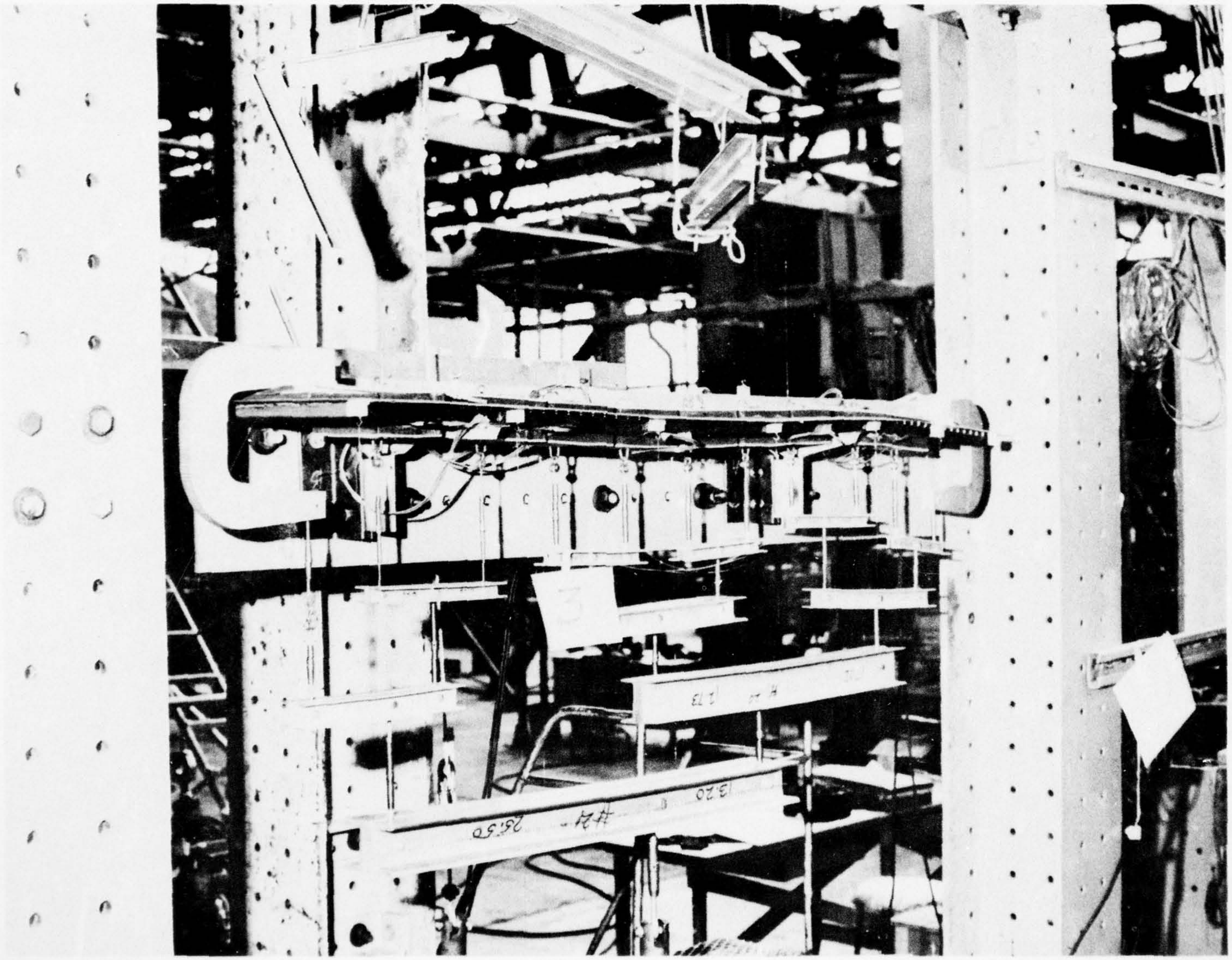


FIGURE B-7 SPOILER LOADED AT 260 PERCENT DLL

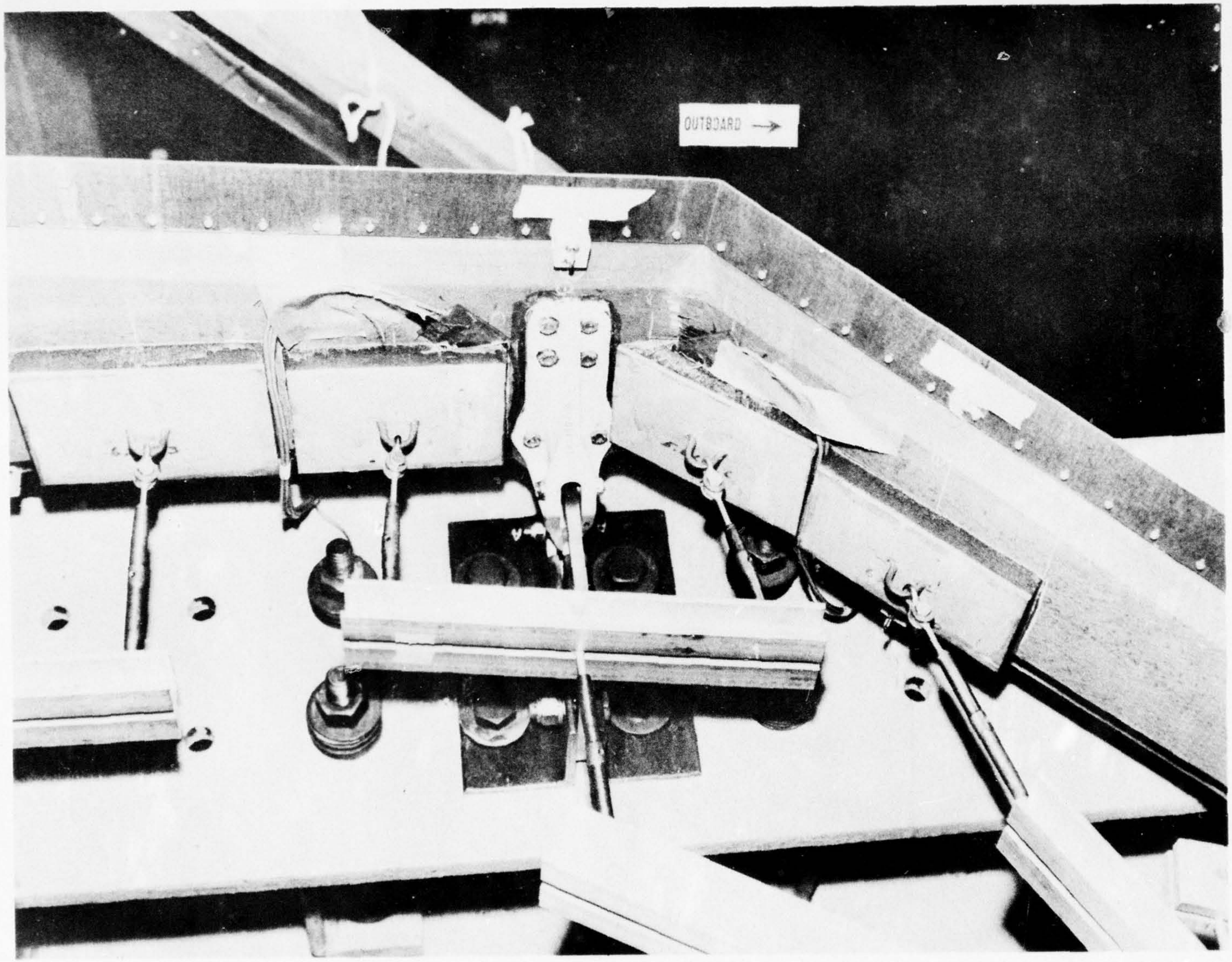
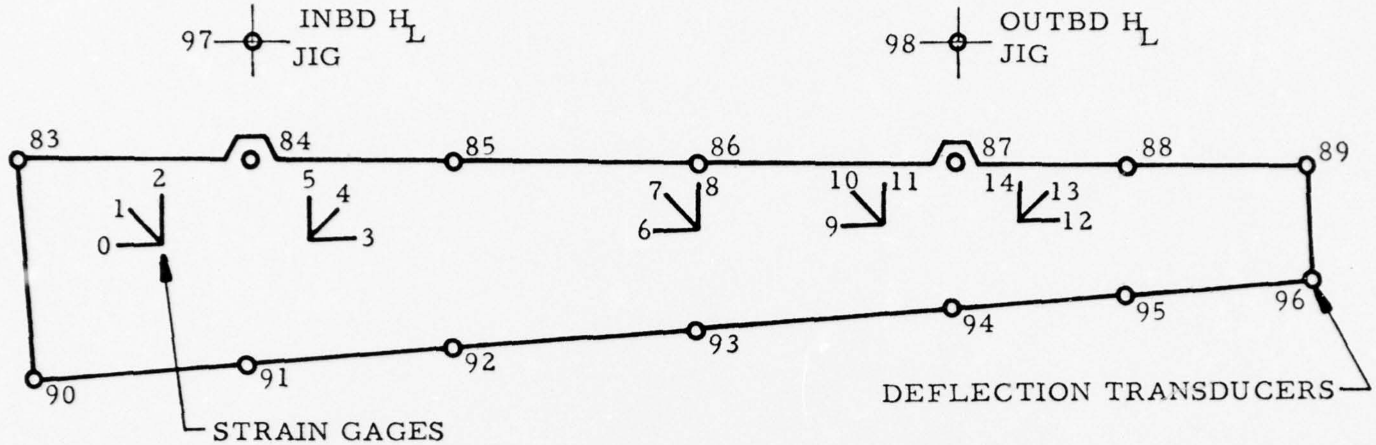


FIGURE B-8 SPOILER FAILED AT 300 PERCENT DLL



STRAIN GAGES	
RECORDING CHANNEL	GAGE LEG
000	0
001	1
002	2
003	3
004	4
005	5
006	6
007	7
008	8
009	9
010	10
011	11
012	12
013	13
014	14

DEFLECTION TRANSDUCERS	
RECORDING CHANNEL	TRANSDUCER
083	83
084	84
085	85
086	86
087	87
088	88
089	89
090	90
091	91
092	92
093	93
094	94
095	95
096	96
097	97
098	98

FIGURE B-9 STATIC TEST INSTRUMENTATION KEY

STATIC TEST #1

RUN NO. 3 115% DLL OPENING LOAD 4/8/74

0%			40%			80%			115%		
099	-02256	0	099	-04224	0	099	-03343	0	099	-04499	0
098	-00093	0	098	-00099	0	098	-00109	0	098	-00114	0
097	-00229	0	097	-00228	0	097	-00233	0	097	-00241	0
096	+00012	0	096	+00063	0	096	+00131	0	096	+00179	0
095	+00010	0	095	+00044	0	095	+00081	0	095	+00114	0
094	+00060	0	094	+00083	0	094	+00103	0	094	+00120	0
093	-00102	0	093	-00007	0	093	-00030	0	093	+00009	0
092	-00111	0	092	-00065	0	092	-00021	0	092	+00021	0
091	+00011	0	091	+00040	0	091	+00079	0	091	+00105	0
090	-00070	0	090	-00040	0	090	-00004	0	090	+00026	0
089	-00084	0	089	-00027	0	089	+00026	0	089	+00072	0
088	-00165	0	088	-00145	0	088	-00122	0	088	-00102	0
087	-00119	0	087	-00121	0	087	-00120	0	087	-00132	0
086	-00006	0	086	+00025	0	086	+00052	0	086	+00082	0
085	-00129	0	085	-00107	0	085	-00075	0	085	-00050	0
084	-00505	0	084	-00510	0	084	-00517	0	084	-00525	0
083	-00109	0	083	-00103	0	083	-00292	0	083	-00082	0
082	500000	0	082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0	080	500000	0
019	500000	0	019	500000	0	019	500000	0	019	500000	0
018	500000	0	018	500000	0	018	500000	0	018	500000	0
017	500000	0	017	500000	0	017	500000	0	017	500000	0
016	500000	0	016	500000	0	016	500000	0	016	500000	0
015	500007	0	015	500000	0	015	500000	0	015	500000	0
014	-00016	0	014	-00077	0	014	-00134	0	014	-00189	0
013	+00013	0	013	+00053	0	013	+00132	0	013	+00145	0
012	+00037	0	012	+00180	0	012	+00319	0	012	+00449	0
011	+00005	0	011	-00000	0	011	-00005	0	011	-00008	0
010	-00009	0	010	+00010	0	010	+00037	0	010	+00057	0
009	+00021	0	009	+00122	0	009	+00218	0	009	+00310	0
008	+00006	0	008	+00024	0	008	+00040	0	008	+00053	0
007	-00029	0	007	-00056	0	007	-00003	0	007	-00108	0
006	-00045	0	006	-00137	0	006	-00231	0	006	-00318	0
005	-00002	0	005	-00012	0	005	-00023	0	005	-00031	0
004	+00003	0	004	-00003	0	004	-00012	0	004	-00019	0
003	-00001	0	003	+00043	0	003	+00001	0	003	+00119	0
002	-00001	0	002	-00020	0	002	-00037	0	002	-00054	0
001	-00000	0	001	-00014	0	001	-00019	0	001	-00025	0
000	[illegible]	0	000	+00050	0	000	+00090	0	000	+00141	0
00-	[illegible]	-	00-	[illegible]	-	00-	111103	-	00-	131734	-
[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	0

STATIC TEST #1

RUN NO. 5 150% DLL CLOSING LOAD 4/9/74

0%			40%			80%		
099	-02000	0	099	-01426	0	099	-01129	0
098	-00151	0	098	-00147	0	098	-00145	0
097	-00190	0	097	-00199	0	097	-00192	0
096	-00089	0	096	-00244	0	096	-00430	0
095	-00086	0	095	-00167	0	095	-00270	0
094	+00955	0	094	+00912	0	094	+00854	0
093	-00252	0	093	-00356	0	093	-00472	0
092	-00259	0	092	-00374	0	092	-00504	0
091	+00929	0	091	+00846	0	091	+00750	0
090	+00961	0	090	+00885	0	090	+00001	0
089	-00158	0	089	-00300	0	089	-00470	0
088	-00220	0	088	-00282	0	088	-00362	0
087	-00089	0	087	-00088	0	087	-00080	0
086	-00061	0	086	-00154	0	086	-00260	0
085	-00211	0	085	-00298	0	085	-00397	0
084	-00395	0	084	-00082	0	084	-00082	0
083	-00211	0	083	-00540	0	083	-00570	0
082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0
019	500000	0	019	500000	0	019	500000	0
018	500000	0	018	500000	0	018	500000	0
017	500000	0	017	500000	0	017	500000	0
016	500000	0	016	500000	0	016	500000	0
015	500000	0	015	500000	0	015	500000	0
014	+00003	0	014	+00175	0	014	+00356	0
013	+00007	0	013	-00145	0	013	-00311	0
012	-00001	0	012	-00440	0	012	-00919	0
011	+00004	0	011	+00010	0	011	+00011	0
010	-00002	0	010	-00085	0	010	-00174	0
009	+00004	0	009	-00318	0	009	-00663	0
008	+00005	0	008	-00051	0	008	-00116	0
007	+00002	0	007	+00073	0	007	+00155	0
006	-00006	0	006	+00275	0	006	+00573	0
005	+00002	0	005	+00028	0	005	+00050	0
004	-00002	0	004	+00025	0	004	+00047	0
003	+00001	0	003	-03124	0	003	-00257	0
002	+00006	0	002	+00055	0	002	+00101	0
001	+00003	0	001	+00015	0	001	+00026	0
000	-00006	0	000	-00147	0	000	-00309	0
00-	11[illegible]38	-	00-	110752	-	00-	11[illegible]	-
000	0 [illegible]	0	000	[illegible]040	0	000	[illegible]00	0

STATIC TEST #1

RUN NO. 5 150% DLL CLOSING LOAD 4/9/74
(CONT.)

120%

099	-03574	0
098	-00137	0
097	-00185	0
096	-00616	0
095	-00373	0
094	+00083	0
093	-00599	0
092	-00640	0
091	+00604	0
090	+00719	0
089	-00641	0
088	-00439	0
087	-00668	0
086	-00304	0
085	-00496	0
084	-00002	0
083	-00594	0
082	500000	0
081	500000	0
080	500000	0
019	500000	0
018	500000	0
017	500000	0
016	500000	0
015	500000	0
014	+00530	0
013	-00485	0
012	-01406	0
011	+00019	0
010	-00262	0
009	-01012	0
008	-00180	0
007	+00237	0
006	+00075	0
005	+00066	0
004	+00609	0
003	-00386	0
002	+00141	0
001	+00013	0
000	-00469	0
00-	111243	-
000	[illegible]125	0

150%

099	-01357	0
098	-00127	0
097	-00180	0
096	-00763	0
095	-00459	0
094	+00758	0
093	-00688	0
092	-00754	0
091	+00593	0
090	+00653	0
089	-00767	0
088	-00494	0
087	-00057	0
086	-00447	0
085	-03577	0
084	-00049	0
083	-00618	0
082	500000	0
081	500000	0
080	500000	0
019	500000	0
018	500000	0
017	500000	0
016	500000	0
015	500000	0
014	+00660	0
013	-00620	0
012	-01778	0
011	+00020	0
010	-00331	0
009	-01276	0
008	-00244	0
007	+00297	0
006	+01106	0
005	+00074	0
004	+00087	0
003	-00484	0
002	+00168	0
001	+00054	0
000	-00590	0
00-	11[illegible]	-
000	[illegible]150	0

STATIC TEST #1

RUN NO. 6 177% DLL CLOSING LOAD 4/9/74

0%			40%			80%		
099	-02713	0	099	-03762	0	099	-0[illegible]	0
098	-00176	0	098	-00166	0	098	-00157	0
097	-00248	0	097	-00242	0	097	-00233	0
096	-00136	0	096	-00292	0	096	-00467	0
095	-00123	0	095	-00206	0	095	-00299	0
094	+00723	0	094	+00686	0	094	+00642	0
093	-00298	0	093	-00389	0	093	-00473	0
092	-00301	0	092	-00412	0	092	-00535	0
091	+00625	0	091	+00757	0	091	+00675	0
090	+00918	0	090	+00852	0	090	+00775	0
089	-00212	0	089	-00340	0	089	-00565	0
088	-00258	0	088	-00315	0	088	-00364	0
087	-00108	0	087	-00104	0	087	-00093	0
086	-00135	0	086	-00185	0	086	-00288	0
085	-00251	0	085	-00329	0	085	-00420	0
084	-00111	0	084	-00102	0	084	-00389	0
083	-00551	0	083	-00576	0	083	-00588	0
082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0
019	500000	0	019	500004	0	019	500000	0
018	500000	0	018	500000	0	018	500000	0
017	500000	0	017	500000	0	017	500000	0
016	500000	0	016	500000	0	016	500000	0
015	500000	0	015	500000	0	015	500000	0
014	-00001	0	014	+00173	0	014	+00352	0
013	+00001	0	013	-00149	0	013	-00313	0
012	-00003	0	012	-00444	0	012	-00922	0
011	+00004	0	011	+00010	0	011	+00014	0
010	-00004	0	010	-00086	0	010	-00175	0
009	-00002	0	009	-00316	0	009	-00061	0
008	+00003	0	008	-00054	0	008	-00119	0
007	+00001	0	007	+00075	0	007	+00158	0
006	-00003	0	006	+00278	0	006	+00583	0
005	-00003	0	005	+00026	0	005	+00046	0
004	+00005	0	004	+00029	0	004	+00051	0
003	-00000	0	003	-00123	0	003	-00255	0
002	+00004	0	002	+00049	0	002	+00095	0
001	-00000	0	001	+00012	0	001	+00026	0
000	-00001	0	000	-00146	0	000	-10336	0
00-	14[illegible]	-	00-	141531	-	00-	1[illegible]31	-
000	[illegible]	0	000	[illegible]	0	000	[illegible]	0

STATIC TEST #1

RUN NO. 6 177% DLL CLOSING LOAD 4/9/74 (CONT.)

120%			150%			177%		
099	-02153	0	099	500000	0	099	-03435	0
098	-00122	0	098	-00125	0	098	-00119	0
097	-00209	0	097	-00202	0	097	-00197	0
096	-00039	0	096	-00763	0	096	-00900	0
095	-00382	0	095	-01459	0	095	-00534	0
094	+00596	0	094	+00558	0	094	+00519	0
093	-00602	0	093	-00722	0	093	-00773	0
092	-00652	0	092	-00745	0	092	-00351	0
091	+00600	0	091	+00554	0	091	+00472	0
090	+00705	0	090	+00055	0	090	+00596	0
089	-00651	0	089	-00793	0	089	-00895	0
088	-00448	0	088	-00503	0	088	-00552	0
087	-00061	0	087	-00094	0	087	-00046	0
086	-00368	0	086	-00455	0	086	-00528	0
085	-00522	0	085	-00665	0	085	-00656	0
084	-00008	0	084	-00008	0	084	-00040	0
083	-00604	0	083	-00621	0	083	-00041	0
082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0
019	500000	0	019	500000	0	019	500000	0
018	500000	0	018	500000	0	018	500000	0
017	500000	0	017	500000	0	017	500000	0
016	500000	0	016	500000	0	016	500000	0
015	500000	0	015	500000	0	015	500000	0
014	+00525	0	014	+00654	0	014	+00765	0
013	-00491	0	013	-00625	0	013	-00749	0
012	-01406	0	012	-01774	0	012	-03103	0
011	+00017	0	011	+00019	0	011	+00014	0
010	-00265	0	010	-00333	0	010	-00395	0
009	-01011	0	009	-01277	0	009	-01513	0
008	-00191	0	008	-00249	0	008	[illegible]	0
007	+00239	0	007	+00297	0	007	+00347	0
006	+00082	0	006	+01107	0	006	+01312	0
005	+00060	0	005	+00071	0	005	+00079	0
004	+00072	0	004	+00089	0	004	+00107	0
003	-00384	0	003	-00483	0	003	-00567	0
002	+00136	0	002	+00164	0	002	+00188	0
001	+00042	0	001	+00053	0	001	+00061	0
000	-00465	0	000	-00584	0	000	-00690	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

STATIC TEST #1

RUN NO. 7 CLOSING CONDITION TO FAILURE 4/9/74

0%			100%			150%			200%		
099	-03161	0	099	-04307	0	099	[illegible]	0	099	-04032	0
098	-00165	0	098	-00137	0	098	-00123	0	098	-00100	0
097	-00229	0	097	-00218	0	097	-00204	0	097	-00192	0
096	-00159	0	096	-00578	0	096	-00795	0	096	-01029	0
095	-00149	0	095	-00363	0	095	-00485	0	095	-00009	0
094	+00699	0	094	+00062	0	094	+00537	0	094	+00472	0
093	-00326	0	093	-00268	0	093	-00712	0	093	-00057	0
092	-00341	0	092	-00616	0	092	-00782	0	092	-03953	0
091	+00790	0	091	+00013	0	091	+00507	0	091	+00400	0
090	+00871	0	090	+00711	0	090	+00617	0	090	+00526	0
089	-00221	0	089	-00596	0	089	-00081	0	089	-01004	0
088	-00266	0	088	-00425	1	088	-00515	0	088	-00006	0
087	-00088	0	087	-00069	0	087	-00052	0	087	-00032	0
086	-00116	0	086	-00338	0	086	-00408	0	086	-00599	0
085	-00268	0	085	-00474	0	085	-00598	0	085	-00727	0
084	-00094	0	084	-00006	0	084	-00045	0	084	-00023	0
083	-00558	0	083	-00000	0	083	-00032	0	083	-00654	0
082	500000	0	082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0	080	500000	0
019	500000	0	019	500000	0	019	500000	0	019	500000	0
018	500000	0	018	500000	0	018	500000	0	018	500000	0
017	500000	0	017	500000	0	017	500000	0	017	500000	0
016	500000	0	016	500000	0	016	500000	0	016	500000	0
015	500000	0	015	500000	0	015	500000	0	015	500000	0
014	+00004	0	014	+00435	0	014	+00043	0	014	+00054	0
013	-00009	0	013	-00414	0	013	-00032	0	013	-00605	0
012	-00008	0	012	-01162	0	012	-01762	0	012	-02394	0
011	-00005	0	011	+00007	0	011	+00005	0	011	+00002	0
010	-00010	0	010	-00226	0	010	-00338	0	010	-00459	0
009	-00007	0	009	-00033	0	009	-01262	0	009	-01718	0
008	+00003	0	008	-00157	0	008	-00250	0	008	-00354	0
007	-00011	0	007	+00188	0	007	+00286	0	007	+00383	0
006	+00001	0	006	+00732	0	006	+01101	0	006	+01488	0
005	-00011	0	005	+00045	0	005	+00062	0	005	+00081	0
004	+00000	0	004	+00060	0	004	+00088	0	004	+00121	0
003	-00004	0	003	-00321	0	003	-00478	0	003	-00643	0
002	-00007	0	002	+00105	0	002	+00154	0	002	+00200	0
001	-00009	0	001	+00026	0	001	+00045	0	001	+00063	0
000	-00008	0	000	-00387	0	000	-00533	0	000	-00736	0
00-	150500	-	00-	150958	-	00-	151117	-	00-	151150	-
000	[illegible]	0	000	[illegible]	0	000	[illegible]	0	000	[illegible]	0

STATIC TEST #1

RUN NO. 7 CLOSING CONDITION TO FAILURE 4/9/74
(CONT.)

240%			280%			290%		
099	-[illegible]	0	099	-[illegible]	0	099	-01282	0
098	-[illegible]	0	098	-00001	0	098	-00081	0
097	-00180	0	097	-00101	0	097	-00169	0
096	-01210	0	096	-01449	0	096	-01401	0
095	-00700	0	095	-00636	0	095	-00012	0
094	+00417	0	094	+00337	0	094	+00353	0
093	-00979	0	093	-01134	0	093	-01185	0
092	-01085	0	092	-01271	0	092	-01235	0
091	+00311	0	091	+00182	0	091	+00205	0
090	+00443	0	090	+00336	0	090	+00356	0
089	-01174	0	089	-01383	0	089	-01345	0
088	-00082	0	088	-00779	0	088	-00708	0
087	-00018	0	087	+00005	0	087	+00001	0
086	-00707	0	086	-00847	0	086	-00023	0
085	-00823	0	085	-00907	0	085	-00942	0
084	-00[illegible]04	0	084	+00029	0	084	+00023	0
083	-00659	0	083	-03050	0	083	-00657	0
082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0
019	500000	0	019	500000	0	019	500000	0
018	500000	0	018	500000	0	018	500000	0
017	500000	0	017	500000	0	017	500000	0
016	500000	0	016	500000	0	016	500000	0
015	500000	0	015	500000	0	015	500000	0
014	+01049	0	014	+01194	0	014	+01159	0
013	-01055	0	013	-01387	0	013	-01256	0
012	-02333	0	012	-03537	0	012	-03360	0
011	-00069	0	011	-00631	0	011	-00027	0
010	-00551	0	010	-00600	0	010	-00642	0
009	-02050	0	009	-02498	0	009	-02409	0
008	-00440	0	008	-00557	0	008	-03532	0
007	+00453	0	007	+00533	0	007	+00913	0
006	+01780	0	006	+02163	0	006	+02067	0
005	+00091	0	005	+00133	0	005	+00098	0
004	+00149	0	004	+00159	0	004	+00180	0
003	-00757	0	003	-00923	0	003	-00508	0
002	+00232	0	002	+00267	0	002	+00260	0
001	+00075	0	001	+00036	0	001	+00084	0
000	-00942	0	000	-01141	0	000	-01140	0
00-	151519	-	00-	151745	-	00-	151720	-
000	[illegible]240	0	000	[illegible]	0	000	[illegible]284	0

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PA. 18974

3033

SUMMARY REPORT ON STATIC TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 2

Ref: (a) LTV Report 2-53440/3R-10108, "Static Test Plan S-3A Composite Spoiler", Revised 27 Feb 1974
(b) NAVAIRDEVCEN ltr report "Summary Report on Static Test Results for the S-3A Graphite Spoiler Number 1" dtd 30 May 1974

Figure B-10 Photograph No. CAD-19396-7-74--Failure of Spoiler at 360 percent DLL.

1. The spoiler was tested statically in two conditions -- the opening condition and the closing condition as described in reference (a). The loading sequence was the same as that for spoiler 1, described in reference (b) except that the spoiler was loaded to a maximum load of 150 percent limit load rather than the designated 115 percent limit load for the opening load condition.

2. The spoiler was installed in the test fixture at the hinges as described in reference (b). The spoiler was loaded successfully to 150 percent DLL in the opening condition without incident. While loading to 177 percent DLL in the closing condition, several tension pads unbonded from the spoiler. To prevent similar occurrences, "C" clamps were installed on the spoiler to transfer the applied loads from the inner surface to the outer surface. Loading was continued to failure. Failure occurred suddenly at 360 percent DLL with no noticeable sound emissions prior to failure. Failure occurred just outboard of the outboard hinge fitting as shown in Figure B-10.

Enclosure (1)

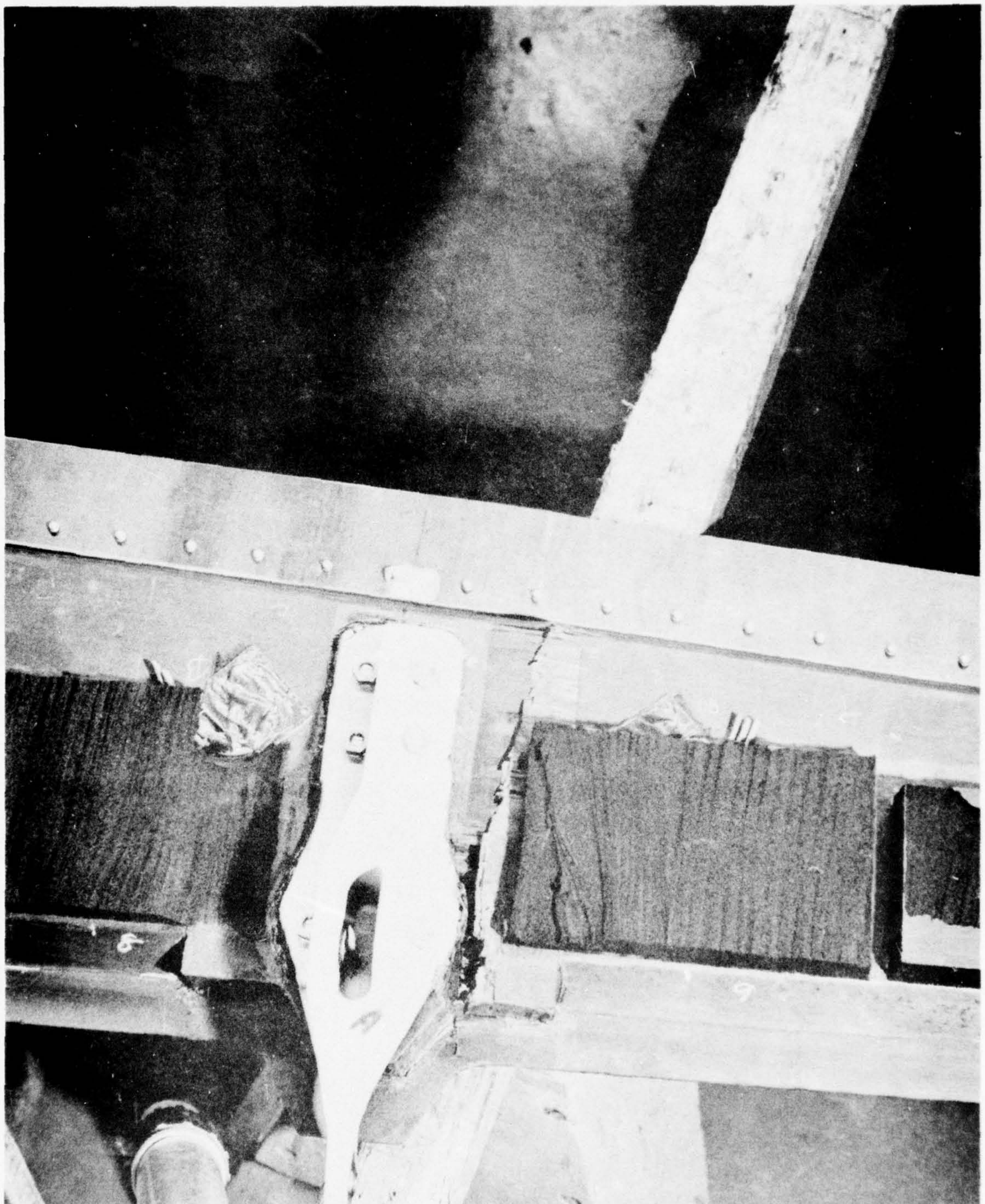


FIGURE B-10 SPOILER NO. 2 --- FAILURE AT 360 PERCENT DLL

STATIC TEST #2

RUN NO. 3 150% DLL OPENING LOAD

0%			40%			80%		
099	-02091	0	099	-03133	0	099	-02164	0
098	-00243	0	098	-00301	0	098	-00387	0
097	-01263	0	097	-03134	0	097	-04001	0
096	-01569	0	096	-03845	0	096	-05060	0
095	-00283	0	095	-00410	0	095	-00591	0
094	-00031	0	094	-14972	0	094	-18494	0
093	+00035	0	093	+00295	0	093	+00219	0
092	-00040	0	092	-00034	0	092	-00056	0
091	-00097	0	091	-00060	0	091	-00068	0
090	-00180	0	090	-00272	0	090	-00371	0
089	-00097	0	089	-00114	0	089	-00179	0
088	-00277	0	088	-00281	0	088	-00310	0
087	-00063	0	087	-00155	0	087	-00263	0
086	-00241	0	086	-00477	0	086	-00724	0
085	-00144	0	085	-00115	0	085	-00085	0
084	-00105	0	084	-00091	0	084	-00083	0
083	-00256	0	083	-00411	0	083	-00589	0
082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	-00034	0
080	200000	0	080	200000	0	080	200000	0
019	-00020	0	019	-00019	0	019	-00020	0
018	+00001	0	018	-00000	0	018	-00002	0
017	+00011	0	017	+00011	0	017	+00010	0
016	+00005	0	016	+00005	0	016	+00003	0
015	500000	0	015	500000	0	015	500000	0
014	-00005	0	014	-00067	0	014	-00123	0
013	+00001	0	013	+00045	0	013	+00078	0
012	-00002	0	012	+00153	0	012	+00282	0
011	-00001	0	011	-00015	0	011	-00032	0
010	-00001	0	010	+00034	0	010	+00055	0
009	-00004	0	009	+00119	0	009	+00216	0
008	+00002	0	008	+00026	0	008	+00038	0
007	-00000	0	007	-00016	0	007	-00037	0
006	-00001	0	006	-00095	0	006	-00183	0
005	+00005	0	005	-00003	0	005	-00015	0
004	-00001	0	004	-00005	0	004	-00014	0
003	+00001	0	003	+00043	0	003	+00077	0
002	-00004	0	002	-00021	0	002	-00041	0
001	-00003	0	001	-00003	0	001	-00013	0
000	+00000	0	000	+00055	0	000	+00093	0
00-	090752	-	00-	090911	-	000	091009	0
000	000000	0	000	000040	0			

STATIC TEST #2
RUN NO. 3 150% DLL OPENING LOAD
(CONT.)

120%			150%		
099	-02543	0	099	-01758	0
098	-00491	0	098	-00503	0
097	-07357	0	097	-10486	0
096	-06968	0	096	-09271	0
095	-00000	0	095	-01007	0
094	-21782	0	094	-23901	0
093	+00357	0	093	+00616	0
092	-00089	0	092	+00030	0
091	-00092	0	091	+00001	0
090	-00008	0	090	-00682	0
089	-00297	0	089	-00372	0
088	-00351	0	088	-00423	0
087	-00451	0	087	-00007	0
086	-01038	0	086	-01484	0
085	-00085	0	085	-00017	0
084	-00066	0	084	-00010	0
083	-00799	0	083	-01068	0
082	200000	0	082	200000	0
081	500000	0	081	500000	0
080	200000	0	080	200000	0
019	-00023	0	019	-00023	0
018	-00005	0	018	-00002	0
017	+00007	0	017	+00007	0
016	+00000	0	016	-00001	0
015	500000	0	015	500000	0
014	-00189	0	014	-00239	0
013	+00120	0	013	+00151	0
012	+00440	0	012	+00550	0
011	-00053	0	011	-00063	0
010	+00081	0	010	+00100	0
009	+00335	0	009	+00419	0
008	+00057	0	008	+00068	0
007	-00065	0	007	-00083	0
006	+00288	0	006	-00362	0
005	-00027	0	005	-00035	0
004	-00017	0	004	-00021	0
003	+00119	0	003	+00151	0
002	-00064	0	002	-00076	0
001	-00020	0	001	-00025	0
000	+00156	0	000	+00196	0
100	001103	0	[illegible]	[illegible]	0

STATIC TEST #2
RUN NO. 6 150%DLL CLOSING LOAD

0%			40%			80%		
099	-00384	0	099	-00704	0	099	+00099	0
098	-00113	0	098	-00108	0	098	-00110	0
097	-00324	0	097	-00319	0	097	-00306	0
096	-00080	0	096	-00237	0	096	-00399	0
095	-00131	0	095	-00211	0	095	-00286	0
094	+00071	0	094	+00048	0	094	+00020	0
093	-00139	0	093	-00219	0	093	-00299	0
092	-00193	0	092	-00292	0	092	-00398	0
091	-00120	0	091	-00174	0	091	-00227	0
090	-00140	0	090	-00196	0	090	-00249	0
089	-00178	0	089	-00327	0	089	-00489	0
088	-00335	0	088	-00403	0	088	-00408	0
087	-00093	0	087	-00095	0	087	-00090	0
086	-00215	0	086	-00292	0	086	-00365	0
085	-00190	0	085	-00270	0	085	-00368	0
084	-00111	0	084	-00104	0	084	-00094	0
083	+00019	0	083	+00007	0	083	-00010	0
082	200000	0	082	500000	0	082	+12730	0
081	-00120	0	081	-20243	0	081	-14023	0
080	-14143	0	080	-18637	0	080	-14382	0
019	-00054	0	019	-00055	0	019	-00054	0
018	-00028	0	018	-00030	0	018	-00029	0
017	+00007	0	017	+00006	0	017	+00007	0
016	-00013	0	016	-00015	0	016	-00014	0
015	500000	0	015	500000	0	015	500000	0
014	+00006	0	014	+00193	0	014	+00380	0
013	-00003	0	013	-00143	0	013	-00294	0
012	+00003	0	012	-00469	0	012	-00964	0
011	-00001	0	011	+00035	0	011	+00070	0
010	+00002	0	010	-00118	0	010	-00245	0
009	-00006	0	009	-00367	0	009	-00741	0
008	+00004	0	008	-00072	0	008	-00154	0
007	-00008	0	007	+00039	0	007	+00086	0
006	-00010	0	006	+00277	0	006	+00579	0
005	+00000	0	005	+00031	0	005	+00052	0
004	-00003	0	004	+00014	0	004	+00034	0
003	-00006	0	003	-00131	0	003	-00258	0
002	+00009	0	002	+00067	0	002	+00126	0
001	-00005	0	001	+00010	0	001	+00024	0
000	+00006	0	000	-00101	0	000	-00335	0
00-	100201	-	00-	100438	-	00-	100010	-
000	000000	0	000	000040	0	000	000080	0

STATIC TEST #2

RUN NO. 6 150% DLL CLOSING LOAD (CONT.)

120%			150%		
099	-02528	0	099	-02795	0
098	-00113	0	098	-00116	0
097	-00305	0	097	-00304	0
096	-00594	0	096	-00714	0
095	-00376	0	095	-00444	0
094	-00020	0	094	-00046	0
093	-00403	0	093	-00486	0
092	-00516	0	092	-00606	0
091	-00305	0	091	-00354	0
090	-00315	0	090	-00361	0
089	-00660	0	089	-00780	0
088	-00544	0	088	-00599	0
087	-00095	0	087	-00087	0
086	-00466	0	086	-00533	0
085	-00469	0	085	-00545	0
084	-00084	0	084	-00082	0
083	-00033	0	083	-00041	0
082	500000	0	082	500000	0
081	-13974	0	081	-23365	0
080	-18129	0	080	-22772	0
019	-00055	0	019	-00055	0
018	-00029	0	018	-00029	0
017	+00007	0	017	+00005	0
016	-00014	0	016	-00014	0
015	500000	0	015	500000	0
014	+00572	0	014	+00697	0
013	-00463	0	013	-00587	0
012	-01491	0	012	-01857	0
011	+00104	0	011	+00126	0
010	-00379	0	010	-00470	0
009	-01144	0	009	-01421	0
008	-00253	0	008	-00325	0
007	+00132	0	007	+00160	0
006	+00908	0	006	+01135	0
005	+00071	0	005	+00080	0
004	+00060	0	004	+00080	0
003	-00387	0	003	-00472	0
002	+00185	0	002	+00227	0
001	+00036	0	001	+00042	0
000	-00524	0	000	-00654	0
100	000128	0	00-	100903	-
			000	000150	0

STATIC TEST #2
RUN NO. 7B 177%DLL CLOSING LOAD

0%			40%			80%		
099	-03767	1	099	+05986	1	099	+01542	1
098	-00103	2	098	-00103	1	098	-00100	1
097	-00253	2	097	-00258	1	097	-00257	2
096	-00057	2	096	-00203	1	096	-00384	2
095	-00108	2	095	-00177	1	095	-00266	2
094	+00092	2	094	+00067	1	094	+00038	0
093	-00246	2	093	-00320	2	093	-00416	0
092	-00235	2	092	-00320	2	092	-00434	0
091	-00355	2	091	-00407	1	091	-00474	0
090	-00039	2	090	-00086	2	090	-00147	0
089	-00190	2	089	-00324	2	089	-00492	0
088	+00090	2	088	+00041	2	088	-00027	0
087	-00080	2	087	-00081	2	087	-00074	2
086	-00350	2	086	-00410	2	086	-00495	0
085	-00284	2	085	-00351	2	085	-00447	0
084	-00150	0	084	-00145	2	084	-00134	0
083	-00083	0	083	-00085	0	083	-00105	0
082	500000	2	082	500000	0	082	500000	0
081	-01054	2	081	-00251	0	081	-05439	0
080	-06693	0	080	-08204	0	080	-06161	0
019	-00040	0	019	-00046	0	019	-00047	2
018	-00020	0	018	-00020	0	018	-00021	0
017	+00004	0	017	+00003	0	017	+00003	0
016	-00008	0	016	-00008	0	016	-00008	0
015	500000	0	015	500000	0	015	500000	0
014	-00000	0	014	+00173	0	014	+00373	0
013	+00003	0	013	-00124	0	013	-00279	0
012	+00003	0	012	-00423	0	012	-00942	0
011	+00003	0	011	+00038	0	011	+00075	0
010	+00002	0	010	-00098	0	010	-00222	0
009	+00000	0	009	-00332	0	009	-00720	0
008	+00001	0	008	-00065	0	008	-00152	0
007	+00002	0	007	+00046	0	007	+00102	0
006	+00001	0	006	+00262	0	006	+00587	0
005	+00003	0	005	+00023	0	005	+00043	0
004	-00001	0	004	+00020	0	004	+00045	0
003	-00002	0	003	-00116	0	003	-00249	0
002	+00003	0	002	+00044	0	002	+00099	0
001	-00000	0	001	+00008	0	001	+00020	0
000	-00001	0	000	-00151	0	000	-00337	0
00-	135845	-	00-	140602	-	00-	140723	-
000	000135	0	000	000040	0	000	000080	0

STATIC TEST #2
RUN NO. 7B 177%DLL CLOSING LOAD
(CONT.)

120%			150%			177%		
099	-00310	0	099	-01871	0	099	-00340	0
098	-00093	0	098	-00098	0	098	-00091	0
097	-00247	0	097	-00247	0	097	-00241	0
096	-00560	0	096	-00697	0	096	-00613	0
095	-00353	0	095	-00413	0	095	-00472	0
094	+00010	0	094	-00021	0	094	-00044	0
093	-00502	0	093	-00577	0	093	-00642	0
092	-00549	0	092	-00637	0	092	-00709	0
091	-00533	0	091	-00585	0	091	-00625	0
090	-00200	0	090	-00238	0	090	-00276	0
089	-00647	0	089	-00771	0	089	-00679	0
088	-00096	0	088	-00153	0	088	-00197	0
087	-00067	0	087	-00064	0	087	-00057	0
086	-00581	0	086	-00653	0	086	-00710	0
085	-00540	0	085	-00621	0	085	-00088	0
084	-00121	0	084	-00119	0	084	-00108	0
083	-00117	0	083	-00124	0	083	-00134	0
082	500000	0	082	500000	0	082	500000	0
081	-05682	0	081	-12377	0	081	-14433	0
080	-04835	0	080	-11537	0	080	-12888	0
019	-00046	0	019	-00046	0	019	-00045	0
018	-00021	0	018	-00020	0	018	-00021	0
017	+00004	0	017	+00003	0	017	+00003	0
016	-00009	0	016	-00008	0	016	-00008	0
015	500009	0	015	500000	0	015	500000	0
014	+00554	0	014	+00690	0	014	+00805	0
013	-00432	0	013	-00553	0	013	-00664	0
012	-01436	0	012	-01815	0	012	-02156	0
011	+00109	0	011	+00133	0	011	+00152	0
010	-00340	0	010	-00428	0	010	-00510	0
009	-01108	0	009	-01397	0	009	-01657	0
008	-00244	0	008	-00315	0	008	-00383	0
007	+00154	0	007	+00193	0	007	+00226	0
006	+00899	0	006	+01141	0	006	+01355	0
005	+00060	0	005	+00072	0	005	+00083	0
004	+00069	0	004	+00090	0	004	+00107	0
003	-00369	0	003	-00459	0	003	-00538	0
002	+00150	0	002	+00189	0	002	+00221	0
001	+00033	0	001	+00041	0	001	+00048	0
000	-00515	0	000	-00648	0	000	-00768	0
00-	140932	-	00-	141013	-	00-	141131	-
000	000120	0	000	000150	0	000	000177	0

STATIC TEST #2
RUN NO. 9 CLOSING CONDITION TO FAILURE

0%			40%			80%			120%		
099	+00246	0	099	+02717	0	099	-03312	0	099	-01278	0
098	-00084	0	098	-00083	0	098	-00081	0	098	-00079	0
097	-00249	0	097	-00246	0	097	-00249	0	097	-00242	0
096	-00075	0	096	-00216	0	096	-00391	0	096	-00572	0
095	-00116	0	095	-00183	0	095	-00264	0	095	-00346	0
094	+00067	0	094	+00043	0	094	+00020	0	094	-00016	0
093	-00255	0	093	-00328	0	093	-00420	0	093	-00519	0
092	-00251	0	092	-00341	0	092	-00448	0	092	-00563	0
091	-00366	0	091	-00411	0	091	-00478	0	091	-00536	0
090	-00049	0	090	-00100	0	090	-00151	0	090	-00204	0
089	-00175	0	089	-00311	0	089	-00471	0	089	-00627	0
088	-00253	0	088	-00320	0	088	-00381	0	088	-00448	0
087	-00065	0	087	-00054	0	087	-00059	0	087	-00051	0
086	-00336	0	086	-00409	0	086	-00484	0	086	-00571	0
085	-00278	0	085	-00331	0	085	-00434	0	085	-00533	0
084	-00129	0	084	-00129	0	084	-00119	0	084	-00107	0
083	-00050	0	083	-00072	0	083	-00082	0	083	-00095	0
082	500000	0	082	+12316	0	082	+09397	0	082	+13034	0
081	+05750	0	081	-02718	0	081	-01414	0	081	-11338	0
080	+00112	0	080	-04123	0	080	-04009	0	080	-07897	0
019	-00026	0	019	-00027	0	019	-00027	0	019	-00026	0
018	-00016	0	018	-00014	0	018	-00014	0	018	-00014	0
017	+00031	0	017	+00031	0	017	+00032	0	017	+00032	0
016	+00019	0	016	+00020	0	016	+00021	0	016	+00021	0
015	500000	0	015	500000	0	015	500000	0	015	500000	0
014	+00039	0	014	+00211	0	014	+00401	0	014	+00564	0
013	+00033	0	013	-00091	0	013	-00239	0	013	-00394	0
012	+00047	0	012	-00377	0	012	-00874	0	012	-01373	0
011	-00002	0	011	+00041	0	011	+00077	0	011	+00109	0
010	+00042	0	010	-00046	0	010	-00168	0	010	-00281	0
009	+00032	0	009	-00292	0	009	-00672	0	009	-01053	0
008	+00015	0	008	-00051	0	008	-00137	0	008	-00228	0
007	+00042	0	007	+00089	0	007	+00144	0	007	+00196	0
006	+00061	0	006	+00329	0	006	+00644	0	006	+00962	0
005	+00011	0	005	+00035	0	005	+00055	0	005	+00071	0
004	+00033	0	004	+00056	0	004	+00080	0	004	+00107	0
003	+00055	0	003	-00059	0	003	-00183	0	003	-00304	0
002	+00018	0	002	+00062	0	002	+00112	0	002	+00164	0
001	+00035	0	001	+00043	0	001	+00055	0	001	+00066	0
000	+00050	0	000	-00099	0	000	-00277	0	000	-00453	0
00-	100117	-	000	[illegible]	.	00-	102400	-	00-	102444	-
000	000000	0				000	000080	0	000	000120	0

STATIC TEST #2
RUN NO. 9 CLOSING CONDITION TO FAILURE
(CONT.)

160%			200%			240%		
Ø99	+ØØ6Ø3	Ø	Ø99	-Ø4225	Ø	Ø99	-Ø3417	Ø
Ø98	-ØØØ74	Ø	Ø98	-ØØØ7Ø	Ø	Ø98	-ØØØ56	Ø
Ø97	-ØØ256	Ø	Ø97	-ØØ23Ø	Ø	Ø97	-ØØ225	Ø
Ø96	-ØØ741	Ø	Ø96	-ØØ92Ø	Ø	Ø96	-Ø1Ø96	Ø
Ø95	-ØØ435	Ø	Ø95	-ØØ512	Ø	Ø95	-ØØ597	Ø
Ø94	-ØØØ47	Ø	Ø94	-ØØØ8Ø	Ø	Ø94	-ØØ1Ø8	Ø
Ø93	-ØØ611	Ø	Ø93	-ØØ7Ø6	Ø	Ø93	-ØØ795	Ø
Ø92	-ØØ673	Ø	Ø92	-ØØ783	Ø	Ø92	-ØØ897	Ø
Ø91	-ØØ599	Ø	Ø91	-ØØ66Ø	Ø	Ø91	-ØØ716	Ø
Ø9Ø	-ØØ254	Ø	Ø9Ø	-ØØ3Ø2	Ø	Ø9Ø	-ØØ349	Ø
Ø89	-ØØ792	Ø	Ø89	-ØØ945	Ø	Ø89	-Ø1115	Ø
Ø88	-ØØ5Ø8	Ø	Ø88	-ØØ583	Ø	Ø88	+ØØØ55	Ø
Ø87	-ØØØ42	Ø	Ø87	-ØØØ35	Ø	Ø87	-ØØØ31	Ø
Ø86	-ØØØ62	Ø	Ø86	-ØØ75Ø	Ø	Ø86	-ØØ845	Ø
Ø85	-ØØØ34	Ø	Ø85	-ØØ734	Ø	Ø85	-ØØ836	Ø
Ø84	-ØØ1Ø2	Ø	Ø84	-ØØØ88	Ø	Ø84	-ØØØ79	Ø
Ø83	-ØØ1Ø7	Ø	Ø83	-ØØ114	Ø	Ø83	-ØØ121	Ø
Ø82	+1ØØ72	Ø	Ø82	+13678	Ø	Ø82	+1125Ø	Ø
Ø81	-Ø887Ø	Ø	Ø81	-1ØØ22	Ø	Ø81	-1ØØ86	Ø
Ø8Ø	-Ø5813	Ø	Ø8Ø	-Ø7574	Ø	Ø8Ø	-Ø7944	Ø
Ø19	-ØØØ27	Ø	Ø19	-ØØØ26	Ø	Ø19	-ØØØ26	Ø
Ø18	-ØØØ13	Ø	Ø18	-ØØØ13	Ø	Ø18	-ØØØ15	Ø
Ø17	+ØØØ31	Ø	Ø17	+ØØØ31	Ø	Ø17	+ØØØ32	Ø
Ø16	+ØØØ21	Ø	Ø16	+ØØØ21	Ø	Ø16	+ØØØ2Ø	Ø
Ø15	5ØØØØØ	Ø	Ø15	5ØØØØØ	Ø	Ø15	5ØØØØØ	Ø
Ø14	+ØØ762	Ø	Ø14	+ØØ932	Ø	Ø14	+Ø11ØØ	Ø
Ø13	-ØØ557	Ø	Ø13	-ØØ723	Ø	Ø13	-ØØ9Ø2	Ø
Ø12	-Ø1879	Ø	Ø12	-Ø2383	Ø	Ø12	-Ø29Ø4	Ø
Ø11	+ØØ139	Ø	Ø11	+ØØ163	Ø	Ø11	+ØØ184	Ø
Ø1Ø	-ØØ4ØØ	Ø	Ø1Ø	-ØØ518	Ø	Ø1Ø	-ØØ644	Ø
ØØ9	-Ø144Ø	Ø	ØØ9	-Ø1825	Ø	ØØ9	-Ø2221	Ø
ØØ8	-ØØ327	Ø	ØØ8	-ØØ431	Ø	ØØ8	-ØØ541	Ø
ØØ7	+ØØ248	Ø	ØØ7	+ØØ29Ø	Ø	ØØ7	+ØØ344	Ø
ØØ6	+Ø1285	Ø	ØØ6	+Ø16Ø3	Ø	ØØ6	+Ø1924	Ø
ØØ5	+ØØØ86	Ø	ØØ5	+ØØ1ØØ	Ø	ØØ5	+ØØ111	Ø
ØØ4	+ØØ136	Ø	ØØ4	+ØØ165	Ø	ØØ4	+ØØ193	Ø
ØØ3	-ØØ423	Ø	ØØ3	-ØØ539	Ø	ØØ3	-ØØ657	Ø
ØØ2	+ØØ213	Ø	ØØ2	+ØØ258	Ø	ØØ2	+ØØ3Ø3	Ø
ØØ1	+ØØØ75	Ø	ØØ1	+ØØØ85	Ø	ØØ1	+ØØØ92	Ø
ØØØ	-ØØ631	Ø	ØØØ	-ØØ8Ø6	Ø	ØØØ	-ØØ986	Ø
ØØ-	1Ø2528	-	ØØ-	1Ø2612	-	ØØ-	1Ø2653	-
ØØØ	ØØØ16Ø	Ø	ØØØ	ØØØ2ØØ	Ø	ØØØ	ØØØ24Ø	Ø

STATIC TEST #2
RUN NO. 9 CLOSING CONDITION TO FAILURE
(CONT.)

280%			320%			350%		
099	+00272	0	099	-01656	0	099	+02377	0
098	-00064	0	098	-00056	0	098	-00049	0
097	-00222	0	097	-00221	0	097	-00285	0
096	-01269	0	096	-01461	0	096	-01594	0
095	-00691	0	095	-00779	0	095	-00854	0
094	-00148	0	094	-00189	0	094	-00220	0
093	-00905	0	093	-01005	0	093	-01002	0
092	-01023	0	092	-01141	0	092	-01243	0
091	-00789	0	091	-00853	0	091	-00922	0
090	-00411	0	090	-00468	0	090	-00512	0
089	-01278	0	089	-01441	0	089	-01569	0
088	-00726	0	088	-00800	0	088	-00864	0
087	-00016	0	087	-00003	0	087	+00008	0
086	-00940	0	086	-01004	0	086	-01004	0
085	-00945	0	085	-01049	0	085	-01131	0
084	-00071	0	084	-00052	0	084	-00034	0
083	-00138	0	083	-00150	0	083	-00163	0
082	+10743	0	082	+06330	0	082	+13624	0
081	-09057	0	081	-11961	0	081	-14658	0
080	-06870	0	080	-09073	0	080	-13314	0
019	-00025	0	019	-00025	0	019	-00025	0
018	-00013	0	018	-00013	0	018	-00014	0
017	+00032	0	017	+00032	0	017	+00033	0
016	+00021	0	016	+00022	0	016	+00021	0
015	500000	0	015	500000	0	015	500000	0
014	+01256	0	014	+01394	0	014	+01498	0
013	-01091	0	013	-01283	0	013	-01447	0
012	-03423	9	012	-03920	0	012	-04333	0
011	+00197	0	011	+00194	0	011	+00184	0
010	-00766	0	010	-00885	0	010	-00980	0
009	-02611	0	009	-02977	0	009	-03272	0
008	-00655	0	008	-00768	0	008	-00862	0
007	+00387	0	007	+00423	0	007	+00448	0
006	+02244	0	006	+02544	0	006	+02787	0
005	+00116	0	005	+00113	0	005	+00107	0
004	+00220	0	004	+00243	0	004	+00261	0
003	-00773	0	003	-00881	0	003	-00968	0
002	+00346	0	002	+00381	0	002	+00408	0
001	+00099	0	001	+00102	0	001	+00105	0
000	-01166	0	000	-01337	0	000	-01479	0
00-	102756	-	00-	102847	-	00-	102932	-
000	000280	0	000	000320	0	000	000350	0

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PA. 18974

3033

SUMMARY REPORT ON STATIC TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 3

Ref: (a) LTV Report 2-53440/3R-10108, "Static Test Plan S-3A Composite Spoiler", Revised 27 Feb 1974
(b) NAVAIRDEVCEN ltr report "Summary Report on Static Test Results for the S-3A Graphite Spoiler Number 1, dtd 30 May 1974

Figure B-11 Photograph No. CAD-20807-12-74--**Failure of Spoiler at 375 percent DLL.**

1. The spoiler was tested statically in two conditions -- the opening condition and the closing condition as described in reference (a). The loading sequence was the same as that for spoiler 1, described in reference (b) except that the spoiler was loaded to a maximum load of 150 percent limit load rather than the designated 115 percent limit load for the opening load condition.

2. The spoiler was installed in the test fixture at the hinges as described in reference (b). The spoiler was loaded 150 percent DLL in the opening condition without incident. While loading to 170 percent DLL in the closing condition, a tension pad unbonded. A "C" clamp was installed to transfer the applied load from the inner surface to the outer surface. Loading was continued to 350 percent DLL at which point another tension pad unbonded. It was decided to install "C" clamps on all tension pads to prevent similar occurrences. Loading was continued to failure at 375 percent DLL with no noticeable sound emissions prior to failure. Failure occurred at the edge of the doubler outboard of the outboard hinge fitting. The failure is shown in Figure B-11.

Enclosure (2)

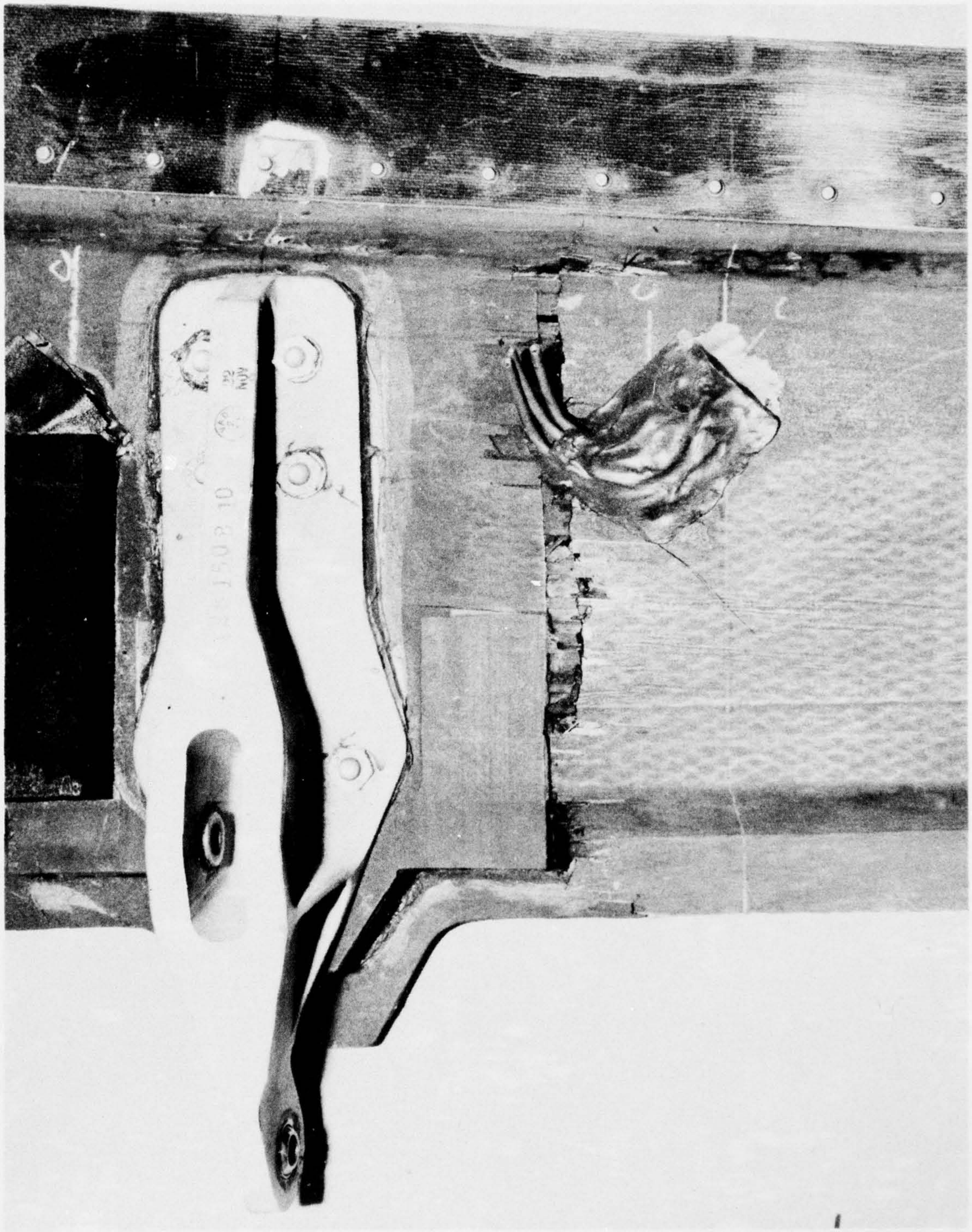


FIGURE B-11 SPOILER NO. 3 --- FAILURE AT 375 PERCENT DLL

STATIC TEST #3
RUN NO. 3 150%DLL OPENING LOAD

0%			40%			80%		
099	+07006	0	099	+05168	0	099	+06703	0
098	-00032	0	098	-00011	0	098	-00015	0
097	-00014	0	097	-00003	0	097	-00004	0
096	-00011	0	096	+00053	0	096	+00099	0
095	-00014	0	095	+00019	0	095	+00042	0
094	-00013	0	094	+00003	0	094	+00012	0
093	+00006	0	093	+00035	0	093	+00060	0
092	+00014	0	092	+00043	0	092	+00070	0
091	-00000	0	091	+00015	0	091	+00036	0
090	+00002	0	090	+00023	0	090	+00047	0
089	-00047	0	089	+00034	0	089	+00079	0
088	-00007	0	088	+00025	0	088	+00042	0
087	-00021	0	087	-00002	0	087	-00006	0
086	-00002	0	086	+00029	0	086	+00047	0
085	-00019	0	085	+00020	0	085	+00043	0
084	-00006	0	084	+00003	0	084	+00001	0
083	-00009	0	083	+00004	0	083	+00006	0
082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200000	0	080	200000	0
019	+00046	0	019	+00044	0	019	+00044	0
018	+00033	0	018	+00031	0	018	+00031	0
017	+00047	0	017	+00043	0	017	+00044	0
016	+00065	0	016	+00061	0	016	+00062	0
015	500000	0	015	500000	0	015	500000	0
014	+00006	0	014	-00057	0	014	-00107	0
013	+00004	0	013	+00043	0	013	+00079	0
012	+00013	0	012	+00156	0	012	+00279	0
011	+00012	0	011	-00014	0	011	-00029	0
010	+00004	0	010	+00020	0	010	+00036	0
009	+00006	0	009	+00113	0	009	+00206	0
008	+00010	0	008	+00025	0	008	+00038	0
007	+00006	0	007	-00018	0	007	-00035	0
006	-00012	0	006	-00101	0	006	-00178	0
005	+00013	0	005	-00003	0	005	-00013	0
004	+00003	0	004	-00006	0	004	-00013	0
003	+00009	0	003	+00047	0	003	+00081	0
002	+00004	0	002	-00021	0	002	-00039	0
001	+00009	0	001	-00001	0	001	-00085	0
000	+00010	0	000	+00058	0	000	+00100	0
00-	004338	-	00-	003835	-	00-	003916	-
000	000133	0	000	000133	0	000	000133	0

STATIC TEST #3
RUN NO. 3 150%DLL OPENING LOAD
(CONT.)

120%			150%		
099	+07000	0	099	+00045	0
098	-00020	0	098	-00021	0
097	-00011	0	097	-00012	0
096	+00160	0	096	+00209	0
095	+00070	0	095	+00092	0
094	+00018	0	094	+00027	0
093	+00088	0	093	+00108	0
092	+00111	0	092	+00143	0
091	+00056	0	091	+00079	0
090	+00068	0	090	+00094	0
089	+00130	0	089	+00167	0
088	+00065	0	088	+00082	0
087	-00012	0	087	-00019	0
086	+00068	0	086	+00084	0
085	+00067	0	085	+00088	0
084	-00006	0	084	-00011	0
083	+00011	0	083	+00016	0
082	200000	0	082	200000	0
081	200000	0	081	200000	0
080	200000	0	080	200000	0
019	+00044	0	019	+00044	0
018	+00030	0	018	+00032	0
017	+00044	0	017	+00045	0
016	+00061	0	016	+00062	0
015	500000	0	015	500000	0
014	-00165	0	014	-00206	0
013	+00122	0	013	+00148	0
012	+00421	0	012	+00518	0
011	-00045	0	011	-00058	0
010	+00054	0	010	+00065	0
009	+00315	0	009	+00386	0
008	+00051	0	008	+00059	0
007	-00059	0	007	-00076	0
006	-00265	0	006	-00328	0
005	-00023	0	005	-00033	0
004	-00018	0	004	-00025	0
003	+00121	0	003	+00150	0
002	-00060	0	002	-00073	0
001	-00011	0	001	-00015	0
000	+00148	0	000	+00181	0
00-	004000	-	00-	004046	-
000	000133	0	000	000133	0

STATIC TEST #3

RUN NO. 6 150%DLL CLOSING LOAD

0%			40%			80%		
099	+00293	0	099	+00482	0	099	+08566	0
098	+00005	0	098	+00005	0	098	+00008	0
097	+00026	0	097	+00028	0	097	+00033	0
096	-00006	0	096	-00155	0	096	-00334	0
095	-00007	0	095	-00075	0	095	-00156	0
094	+00004	0	094	-00023	0	094	-00059	0
093	-00006	0	093	-00082	0	093	-00179	0
092	+00011	0	092	-00089	0	092	-00212	0
091	-00024	0	091	-00098	0	091	-00167	0
090	+00016	0	090	-00060	0	090	-00142	0
089	-00069	0	089	-00197	0	089	-00351	0
088	-00003	0	088	-00056	0	088	-00124	0
087	-00004	0	087	-00003	0	087	+00006	0
086	+00010	0	086	-00052	0	086	-00127	0
085	-00021	0	085	-00087	0	085	-00174	0
084	+00031	0	084	+00034	0	084	+00047	0
083	-00005	0	083	-00016	0	083	-00030	0
082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200000	0	080	200000	0
019	+00022	0	019	+00024	0	019	+00027	0
018	+00013	0	018	+00015	0	018	+00014	0
017	+00046	0	017	+00049	0	017	+00052	0
016	+00073	0	016	+00074	0	016	+00073	0
015	500000	0	015	500000	0	015	500000	0
014	+00012	0	014	+00172	0	014	+00346	0
013	+00003	0	013	-00119	0	013	-00264	0
012	-00015	0	012	-00414	0	012	-00670	0
011	+00020	0	011	+00053	0	011	+00088	0
010	-00015	0	010	-00074	0	010	-00160	0
009	-00015	0	009	-00313	0	009	-00670	0
008	+00003	0	008	-00047	0	008	-00113	0
007	+00033	0	007	+00052	0	007	+00104	0
006	+00020	0	006	+00269	0	006	+00549	0
005	+00007	0	005	+00039	0	005	+00069	0
004	+00024	0	004	+00053	0	004	+00089	0
003	-00007	0	003	-00116	0	003	-00238	0
002	+00008	0	002	+00064	0	002	+00120	0
001	+00005	0	001	+00017	0	001	+00027	0
000	-00004	0	000	-00138	0	000	-00290	0
00[illegible]	00[illegible]132	[illegible]	000	000133	0	000	000143	0

STATIC TEST #3

RUN NO. 6 150%DLL CLOSING LOAD

(CONT.)

120%

Ø99	+Ø9676	Ø
Ø98	+ØØØ11	Ø
Ø97	+ØØØ33	Ø
Ø96	-ØØ512	Ø
Ø95	-ØØ246	Ø
Ø94	-ØØØ94	Ø
Ø93	-ØØ283	Ø
Ø92	-ØØ33Ø	Ø
Ø91	-ØØ236	Ø
Ø9Ø	-ØØ212	Ø
Ø89	-ØØ516	Ø
Ø88	-ØØ188	Ø
Ø87	+ØØØ12	Ø
Ø86	-ØØ2Ø9	Ø
Ø85	-ØØ272	Ø
Ø84	+ØØØ57	Ø
Ø83	-ØØØ42	Ø
Ø82	2ØØØØØ	Ø
Ø81	2ØØØØØ	Ø
Ø8Ø	2ØØØØØ	Ø
Ø19	+ØØØ29	Ø
Ø18	+ØØØ17	Ø
Ø17	+ØØØ53	Ø
Ø16	+ØØØ72	Ø
Ø15	5ØØØØØ	Ø
Ø14	+ØØ517	Ø
Ø13	-ØØ423	Ø
Ø12	-Ø1343	Ø
Ø11	+ØØ117	Ø
Ø1Ø	-ØØ234	Ø
ØØ9	-Ø1Ø31	Ø
ØØ8	-ØØ19Ø	Ø
ØØ7	+ØØ168	Ø
ØØ6	+ØØ845	Ø
ØØ5	+ØØØ94	Ø
ØØ4	+ØØ123	Ø
ØØ3	-ØØ356	Ø
ØØ2	+ØØ174	Ø
ØØ1	+ØØØ39	Ø
ØØØ	-ØØ445	Ø
ØØ-	2134Ø6	-
ØØØ	ØØØ133	Ø

150%

Ø99	+Ø9Ø65	Ø
Ø98	+ØØØ17	Ø
Ø97	+ØØØ4Ø	Ø
Ø96	-ØØ651	Ø
Ø95	-ØØ3Ø9	Ø
Ø94	-ØØ121	Ø
Ø93	-ØØ357	Ø
Ø92	-ØØ416	Ø
Ø91	-ØØ287	Ø
Ø9Ø	-ØØ258	Ø
Ø89	-ØØ637	Ø
Ø88	-ØØ237	Ø
Ø87	+ØØØ22	Ø
Ø86	-ØØ268	Ø
Ø85	-ØØ34Ø	Ø
Ø84	+ØØØØ4	Ø
Ø83	-ØØØ48	Ø
Ø82	2ØØØØØ	Ø
Ø81	2ØØØØØ	Ø
Ø8Ø	2ØØØØØ	Ø
Ø19	+ØØØ26	Ø
Ø18	+ØØØ17	Ø
Ø17	+ØØØ52	Ø
Ø16	+ØØØ75	Ø
Ø15	5ØØØØØ	Ø
Ø14	+ØØ632	Ø
Ø13	-ØØ543	Ø
Ø12	-Ø1682	Ø
Ø11	+ØØ131	Ø
Ø1Ø	-ØØ282	Ø
ØØ9	-Ø128Ø	Ø
ØØ8	-ØØ25Ø	Ø
ØØ7	+ØØ213	Ø
ØØ6	+Ø1Ø59	Ø
ØØ5	+ØØ1Ø8	Ø
ØØ4	+ØØ146	Ø
ØØ3	-ØØ438	Ø
ØØ2	+ØØ2Ø8	Ø
ØØ1	+ØØØ45	Ø
ØØØ	[illegible]	Ø

STATIC TEST #3
RUN NO. 7 177%DLL CLOSING LOAD

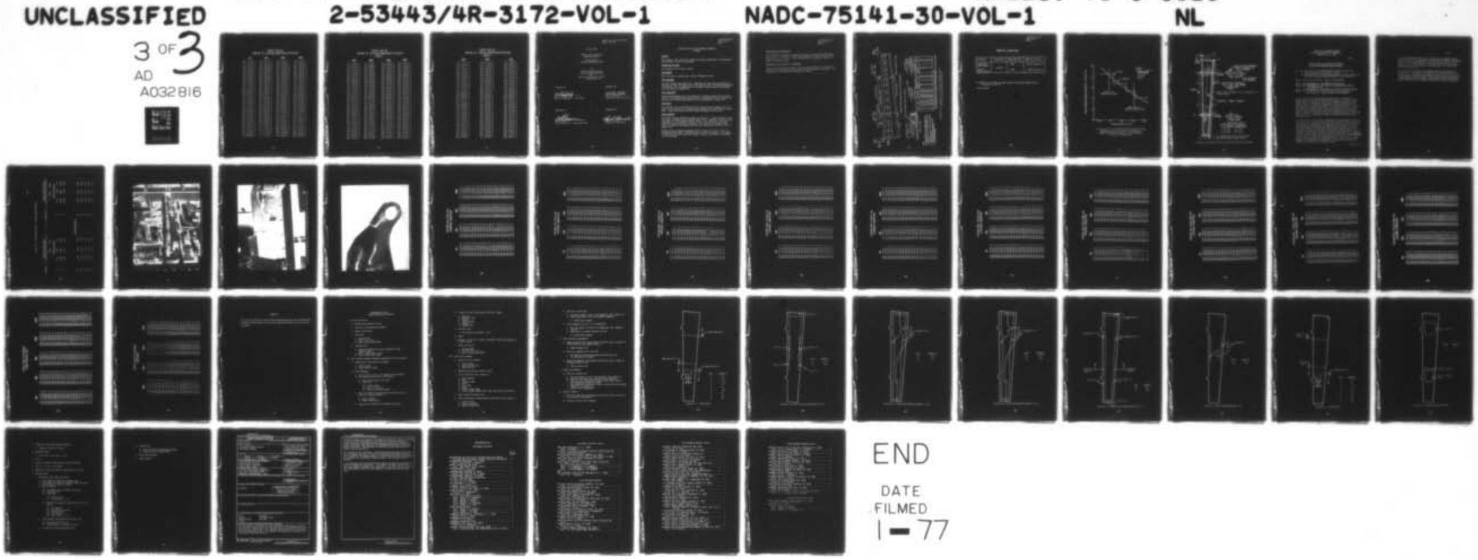
0%			40%			80%		
Ø99	+ØØ4Ø8	Ø	Ø99	+ØØ875	Ø	Ø99	+Ø2Ø6Ø	Ø
Ø98	+ØØØ76	Ø	Ø98	+ØØØ7Ø	Ø	Ø98	+ØØØ66	Ø
Ø97	+ØØØ77	Ø	Ø97	+ØØØ78	Ø	Ø97	+ØØØ76	Ø
Ø96	+ØØØ35	Ø	Ø96	-ØØ116	Ø	Ø96	-ØØ3Ø2	Ø
Ø95	+ØØØ32	Ø	Ø95	-ØØØ39	Ø	Ø95	-ØØ124	Ø
Ø94	+ØØØ38	Ø	Ø94	+ØØØ13	Ø	Ø94	-ØØØ27	Ø
Ø93	+ØØØØ6	Ø	Ø93	-ØØØ81	Ø	Ø93	-ØØ18Ø	Ø
Ø92	-ØØØØØ	Ø	Ø92	-ØØØ92	Ø	Ø92	-ØØ212	Ø
Ø91	-ØØØ13	Ø	Ø91	-ØØØ7Ø	Ø	Ø91	-ØØ153	Ø
Ø9Ø	+ØØØ44	Ø	Ø9Ø	-ØØØ32	Ø	Ø9Ø	-ØØ114	Ø
Ø89	+ØØØ34	Ø	Ø89	-ØØ112	Ø	Ø89	-ØØ274	Ø
Ø88	+ØØØ56	Ø	Ø88	-ØØØØ7	Ø	Ø88	-ØØØ77	Ø
Ø87	+ØØØ78	Ø	Ø87	+ØØØ72	Ø	Ø87	+ØØØ74	Ø
Ø86	+ØØØ59	Ø	Ø86	-ØØØØ7	Ø	Ø86	-ØØØ89	Ø
Ø85	+ØØØ59	Ø	Ø85	-ØØØ13	Ø	Ø85	-ØØ116	Ø
Ø84	+ØØØ75	Ø	Ø84	+ØØØ75	Ø	Ø84	+ØØØ81	Ø
Ø83	+ØØØ72	Ø	Ø83	+ØØØ54	Ø	Ø83	+ØØØ31	Ø
Ø82	2ØØØØØ	Ø	Ø82	2ØØØØØ	Ø	Ø82	2ØØØØØ	Ø
Ø81	2ØØØØØ	Ø	Ø81	2ØØØØØ	Ø	Ø81	2ØØØØØ	Ø
Ø8Ø	2ØØØØØ	Ø	Ø8Ø	2ØØØØØ	Ø	Ø8Ø	2ØØØØØ	Ø
Ø19	-ØØØØ2	Ø	Ø19	-ØØØ34	Ø	Ø19	-ØØØØ2	Ø
Ø18	-ØØØ17	Ø	Ø18	-ØØØ16	Ø	Ø18	-ØØØ15	Ø
Ø17	+ØØØ21	Ø	Ø17	+ØØØ22	Ø	Ø17	+ØØØ23	Ø
Ø16	+ØØØ45	Ø	Ø16	+ØØØ46	Ø	Ø16	+ØØØ46	Ø
Ø15	5ØØØØØ	Ø	Ø15	5ØØØØØ	Ø	Ø15	5ØØØØØ	Ø
Ø14	-ØØØØ9	Ø	Ø14	+ØØ152	Ø	Ø14	+ØØ326	Ø
Ø13	-ØØØ41	Ø	Ø13	-ØØ17Ø	Ø	Ø13	-ØØ315	Ø
Ø12	-ØØØ2Ø	Ø	Ø12	-ØØ43Ø	Ø	Ø12	-ØØ688	Ø
Ø11	-ØØØ1Ø	Ø	Ø11	+ØØØ29	Ø	Ø11	+ØØØ61	Ø
Ø1Ø	-ØØØ28	Ø	Ø1Ø	-ØØØ79	Ø	Ø1Ø	-ØØ159	Ø
ØØ9	-ØØØ2Ø	Ø	ØØ9	-ØØ32Ø	Ø	ØØ9	-ØØ672	Ø
ØØ8	-ØØØ19	Ø	ØØ8	-ØØØ72	Ø	ØØ8	-ØØ138	Ø
ØØ7	-ØØØ19	Ø	ØØ7	+ØØØ31	Ø	ØØ7	+ØØØ85	Ø
ØØ6	+ØØØ24	Ø	ØØ6	+ØØ269	Ø	ØØ6	+ØØ549	Ø
ØØ5	-ØØØ15	Ø	ØØ5	+ØØØ17	Ø	ØØ5	+ØØØ47	Ø
ØØ4	+ØØØØ4	Ø	ØØ4	+ØØØ34	Ø	ØØ4	+ØØØ7Ø	Ø
ØØ3	+ØØØØ8	Ø	ØØ3	-ØØ1Ø8	Ø	ØØ3	-ØØ228	Ø
ØØ2	+ØØØØ3	Ø	ØØ2	+ØØØ65	Ø	ØØ2	+ØØ12Ø	Ø
ØØ1	+ØØØØ6	Ø	ØØ1	+ØØØ19	Ø	ØØ1	+ØØØ3Ø	Ø
ØØØ	+ØØØØ1	Ø	ØØØ	-ØØ137	Ø	ØØØ	-ØØ291	Ø
ØØ-	ØØ4227	-	ØØ-	ØØ4349	-	ØØ-	ØØ4435	-
ØØØ	ØØØ133	Ø	ØØØ	ØØØ133	Ø	ØØØ	ØØØ133	Ø

STATIC TEST #3
RUN NO. 7 177%DLL CLOSING LOAD
(CONT.)

120%			150%			177%		
Ø99	+ØØ162	Ø	Ø99	+Ø34Ø8	Ø	Ø99	+Ø1Ø91	Ø
Ø98	+ØØØ66	Ø	Ø98	+ØØØ65	Ø	Ø98	+ØØØ55	Ø
Ø97	+ØØØ77	Ø	Ø97	+ØØØ77	Ø	Ø97	+ØØØ78	Ø
Ø96	-ØØ468	Ø	Ø96	-ØØ616	Ø	Ø96	-ØØ742	Ø
Ø95	-ØØ2Ø9	Ø	Ø95	-ØØ279	Ø	Ø95	-ØØ342	Ø
Ø94	-ØØØ63	Ø	Ø94	-ØØØ97	Ø	Ø94	-ØØ13Ø	Ø
Ø93	-ØØ276	Ø	Ø93	-ØØ356	Ø	Ø93	-ØØ419	Ø
Ø92	-ØØ325	Ø	Ø92	-ØØ413	Ø	Ø92	-ØØ492	Ø
Ø91	-ØØ224	Ø	Ø91	-ØØ272	Ø	Ø91	-ØØ318	Ø
Ø9Ø	-ØØ183	Ø	Ø9Ø	-ØØ233	Ø	Ø9Ø	-ØØ28Ø	Ø
Ø89	-ØØ443	Ø	Ø89	-ØØ579	Ø	Ø89	-ØØ7Ø2	Ø
Ø88	-ØØ143	Ø	Ø88	-ØØ199	Ø	Ø88	-ØØ253	Ø
Ø87	+ØØØ76	Ø	Ø87	+ØØØ74	Ø	Ø87	+ØØØ72	Ø
Ø86	-ØØ169	Ø	Ø86	-ØØ238	Ø	Ø86	-ØØ3Ø1	Ø
Ø85	-ØØ21Ø	Ø	Ø85	-ØØ29Ø	Ø	Ø85	-ØØ37Ø	Ø
Ø84	+ØØØ88	Ø	Ø84	+ØØØ93	Ø	Ø84	+ØØØ97	Ø
Ø83	+ØØØ15	Ø	Ø83	+ØØØØ4	Ø	Ø83	-ØØØ1Ø	Ø
Ø82	2ØØØØØ	Ø	Ø82	2ØØØØØ	Ø	Ø82	2ØØØØØ	Ø
Ø81	2ØØØØØ	Ø	Ø81	2ØØØØØ	Ø	Ø81	2ØØØØØ	Ø
Ø8Ø	2ØØØØØ	Ø	Ø8Ø	2ØØØØØ	Ø	Ø8Ø	2ØØØØØ	Ø
Ø19	+ØØØØ1	Ø	Ø19	+ØØØØ3	Ø	Ø19	+ØØØØ6	Ø
Ø18	-ØØØ14	Ø	Ø18	-ØØØ12	Ø	Ø18	-ØØØØ9	Ø
Ø17	+ØØØ23	Ø	Ø17	+ØØØ25	Ø	Ø17	+ØØØ28	Ø
Ø16	+ØØØ46	Ø	Ø16	+ØØØ48	Ø	Ø16	+ØØØ51	Ø
Ø15	5ØØØØØ	Ø	Ø15	5ØØØØØ	Ø	Ø15	5ØØØØØ	Ø
Ø14	+ØØ49Ø	Ø	Ø14	+ØØ611	Ø	Ø14	+ØØ715	Ø
Ø13	-ØØ466	Ø	Ø13	-ØØ588	Ø	Ø13	-ØØ7ØØ	Ø
Ø12	-Ø1342	Ø	Ø12	-Ø1693	Ø	Ø12	-Ø2ØØ6	Ø
Ø11	+ØØØ89	Ø	Ø11	+ØØ11Ø	Ø	Ø11	+ØØ128	Ø
Ø1Ø	-ØØ24Ø	Ø	Ø1Ø	-ØØ3ØØ	Ø	Ø1Ø	-ØØ346	Ø
ØØ9	-Ø1Ø23	Ø	ØØ9	-Ø1296	Ø	ØØ9	-Ø1531	Ø
ØØ8	-ØØ213	Ø	ØØ8	-ØØ27Ø	Ø	ØØ8	-ØØ325	Ø
ØØ7	+ØØ142	Ø	ØØ7	+ØØ187	Ø	ØØ7	+ØØ23Ø	Ø
ØØ6	+ØØ825	Ø	ØØ6	+Ø1Ø41	Ø	ØØ6	+Ø1238	Ø
ØØ5	+ØØØ71	Ø	ØØ5	+ØØØ86	Ø	ØØ5	+ØØØ94	Ø
ØØ4	+ØØ1Ø3	Ø	ØØ4	+ØØ129	Ø	ØØ4	+ØØ148	Ø
ØØ3	-ØØ344	Ø	ØØ3	-ØØ433	Ø	ØØ3	-ØØ511	Ø
ØØ2	+ØØ172	Ø	ØØ2	+ØØ212	Ø	ØØ2	+ØØ246	Ø
ØØ1	+ØØØ4Ø	Ø	ØØ1	+ØØØ48	Ø	ØØ1	+ØØØ56	Ø
ØØØ	-ØØ44Ø	Ø	ØØØ	-ØØ555	Ø	ØØØ	-ØØ658	Ø
ØØØ	ØØ4535	Ø	ØØØ	ØØ8Ø31	Ø	ØØØ	ØØ4823	Ø

AD-A032 816 LTV AEROSPACE CORP DALLAS TEX VOUGHT SYSTEMS DIV F/G 1/3
S-3A GRAPHITE/EPOXY SPOILER DEVELOPMENT PROGRAM. VOLUME 1.(U)
AUG 74 O E DHONAU, E G BLOSSER N62269-73-C-0610
UNCLASSIFIED 2-53443/4R-3172-VOL-1 NADC-75141-30-VOL-1 NL

3 OF 3
AD
A032816



END
DATE
FILMED
1-77

OF 3

32816

STATIC TEST #3
RUN NO. 9C CLOSING CONDITION TO FAILURE

0%			40%			80%			120%		
099	+04243	0	099	+05184	0	099	+05340	0	099	+05562	0
098	+00016	0	098	-00005	0	098	-00003	0	098	+00005	0
097	+00010	0	097	-00008	0	097	-00009	0	097	+00002	0
096	+00008	0	096	-00202	0	096	-00371	0	096	-00561	0
095	+00013	0	095	-00083	0	095	-00166	0	095	-00252	0
094	+00007	0	094	-00042	0	094	-00078	0	094	-00115	0
093	+00012	0	093	-00094	0	093	-00188	0	093	-00291	0
092	+00006	0	092	-00125	0	092	-00236	0	092	-00360	0
091	+00016	0	091	-00072	0	091	-00140	0	091	-00213	0
090	+00029	0	090	-00090	0	090	-00159	0	090	-00231	0
089	+00012	0	089	-00182	0	089	-00334	0	089	-00514	0
088	+00017	0	088	-00068	0	088	-00132	0	088	-00205	0
087	+00010	0	087	-00007	0	087	+00001	0	087	+00010	0
086	+00020	0	086	-00074	0	086	-00149	0	086	-00234	0
085	+00016	0	085	-00085	0	085	-00178	0	085	-00282	0
084	+00010	0	084	+00007	0	084	+00014	0	084	+00027	0
083	+00006	0	083	-00029	0	083	-00040	0	083	-00049	0
082	200000	0	082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200000	0	080	200000	0	080	200000	0
019	+00010	0	019	+00016	0	019	+00015	0	019	+00010	0
018	+00013	0	018	+00021	0	018	+00020	0	018	+00020	0
017	+00015	0	017	+00021	0	017	+00021	0	017	+00020	0
016	+00040	0	016	+00045	0	016	+00044	0	016	+00044	0
015	500000	0	015	500000	0	015	500000	0	015	500000	0
014	+00004	0	014	+00155	0	014	+00329	0	014	+00508	0
013	+00001	0	013	-00130	0	013	-00276	0	013	-00442	0
012	+00006	0	012	-00403	0	012	-00843	0	012	-01336	0
011	+00006	0	011	+00003	0	011	+00035	0	011	+00066	0
010	+00007	0	010	-00054	0	010	-00100	0	010	-00171	0
009	+00006	0	009	-00305	0	009	-00523	0	009	-00997	0
008	+00007	0	008	-00053	0	008	-00121	0	008	-00202	0
007	+00010	0	007	+00053	0	007	+00111	0	007	+00176	0
006	+00008	0	006	+00259	0	006	+00534	0	006	+00642	0
005	+00006	0	005	+00025	0	005	+00052	0	005	+00077	0
004	+00003	0	004	+00031	0	004	+00063	0	004	+00101	0
003	+00009	0	003	-00117	0	003	-00231	0	003	-00358	0
002	+00004	0	002	+00063	0	002	+00114	0	002	+00168	0
001	+00005	0	001	+00012	0	001	+00022	0	001	+00030	0
000	-00000	0	000	-00137	0	000	-00283	0	000	-00448	0
00-	024618	-	00-	025313	-	00-	025828	-	00-	025658	-
000	000000	0	000	000000	0	000	000000	0	000	000000	0

STATIC TEST #3
RUN NO. 9C CLOSING CONDITION TO FAILURE
(CONT.)

	160%	200%	240%	280%
099	+05003 0	+05690	+05425 0	+06082 0
098	+00004 0	+00009	+00015 0	+00012 0
097	+00006 0	+00014	+00022 0	+00022 0
096	-00714 0	-00901	-01065 0	-01246 0
095	-00328 0	-00415	-00489 0	-00582 0
094	-00145 0	-00184	-00215 0	-00255 0
093	-00376 0	-00483	-00570 0	-00680 0
092	-00462 0	-00580	-00690 0	-00818 0
091	-00270 0	-00344	-00483 0	-00472 0
090	-00284 0	-00350	-00405 0	-00457 0
089	-00659 0	-00831	-00984 0	-01159 0
088	-00259 0	-00334	-00394 0	-00468 0
087	+00020 0	+00028	+00038 0	+00048 0
086	-00303 0	-00395	-00472 0	-00568 0
085	-00362 0	-00463	-00556 0	-00672 0
084	+00038 0	+00045	+00056 0	+00064 0
083	-00055 0	-00064	-00068 0	+00055 0
082	200000 0	200000	200000 0	-03961 0
081	200000 0	200000	200000 0	-00002 0
080	200000 0	200000	200000 0	200000 0
019	+00015 0	+00016	+00016 0	+00016 0
018	+00020 0	+00020	+00020 0	+00021 0
017	+00020 0	+00020	+00021 0	+00020 0
016	+00045 0	+00044	+00045 0	+00045 0
015	500000 0	500000	500000 0	500000 0
014	+00655 0	+00826	+00971 0	+01135 0
013	-00587 0	-00770	-00939 0	-01149 0
012	-01758 0	-02274	-02736 0	-03279 0
011	+00090 0	+00114	+00128 0	+00140 0
010	-00241 0	-00327	-00403 0	-00488 0
009	-01325 0	-01723	-02075 0	-02491 0
008	-00275 0	-00368	-00457 0	-00566 0
007	+00231 0	+00293	+00346 0	+00400 0
006	+01104 0	+01419	+01698 0	+02024 0
005	+00095 0	+00111	+00116 0	+00121 0
004	+00132 0	+00171	+00193 0	+00236 0
003	-00403 0	-00591	-00704 0	-00830 0
002	+00213 0	+00263	+00333 0	+00349 0
001	+00038 0	+00047	+00053 0	+00059 0
000	-00587 0	-00750	-00986 0	-01079 0
00-	025911 -	025926	025956 -	030044 -
000	000000 0	000000	000000 0	000000 0

STATIC TEST #3
RUN NO. 9C CLOSING CONDITION TO FAILURE
(CONT.)

320%			350%			370%		
099	+02431	0	099	+06311	0	099	+05448	0
098	+00016	0	098	+00016	0	098	+00017	0
097	+00029	0	097	+00030	0	097	+00029	0
096	-01367	0	096	-01390	0	096	-01390	0
095	-00656	0	095	-00720	0	095	-00741	0
094	-00287	0	094	-00315	0	094	-00334	0
093	-00767	0	093	-00769	0	093	-00770	0
092	-00920	0	092	-01009	0	092	-01058	0
091	-00527	0	091	-00576	0	091	-00611	0
090	-00456	0	090	-00455	0	090	-00456	0
089	-01277	0	089	-01281	0	089	-01281	0
088	-00531	0	088	-00566	0	088	-00568	0
087	+00056	0	087	+00061	0	087	+00065	0
086	-00048	0	086	-00714	0	086	-00746	0
085	-00770	0	085	-00845	0	085	-00885	0
084	+00075	0	084	+00083	0	084	+00088	0
083	-00081	0	083	-00083	0	083	-00086	0
082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200000	0	080	200000	0
019	+00016	0	019	+00017	0	019	+00017	0
018	+00022	0	018	+00022	0	018	+00022	0
017	+00021	0	017	+00021	0	017	+00021	0
016	+00046	0	016	+00045	0	016	+00046	0
015	500000	0	015	500000	0	015	500000	0
014	+01262	0	014	+01367	0	014	+01414	0
013	-01332	0	013	-01480	0	013	-01554	0
012	-03724	0	012	-04092	0	012	-04269	0
011	+00146	0	011	+00150	0	011	+00148	0
010	-00546	0	010	-00612	0	010	-00647	0
009	-02823	0	009	-03098	0	009	-03226	0
008	-00666	0	008	-00743	0	008	-00783	0
007	+00436	0	007	+00469	0	007	+00483	0
006	+02294	0	006	+02512	0	006	+02621	0
005	+00124	0	005	+00126	0	005	+00123	0
004	+00277	0	004	+00307	0	004	+00321	0
003	-00929	0	003	-01011	0	003	-01048	0
002	+00387	0	002	+00416	0	002	+00430	0
001	+00060	0	001	+00062	0	001	+00062	0
000	-01222	0	000	-01340	0	000	-01397	0
00-	030206	-	00-	030248	-	00-	030311	--
000	000000	0	000	000000	0	000	000000	0

Report No. 2-53440/3R-10102
Rev. A 6/17/74

17 June 1974

Fatigue Test Plan S-3A
Composite Spoiler

Prepared Under
Contract N62269-73-C-0610

BY
Vought Systems Division
LTV Aerospace Corporation
FOR
Naval Air Development Center
Warminister, Pa.

PREPARED BY:

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APPROVED BY:

Leon E. Boswell
Supervisor, Structures

FATIGUE TEST PLAN S-3A ADVANCED COMPOSITE SPOILER

PURPOSE:

The purpose of this test is to verify the fatigue capability of the graphite/epoxy spoiler for the S-3A aircraft.

DESCRIPTION OF TEST:

The specimen will be cyclic tested.

REQUIREMENT:

This test plan is required per contract N62269-73-C-0610.

TEST SPECIMEN:

The test specimen will consist of a graphite S-3A lower spoiler assembly as described in Dwg. 78-002553; Flap - S-3A Spoiler, LWR. O.P. Advanced Composite. The specimen will be supported at the actuator hinge fittings thru mounting holes, as shown in Figure B-10.

TEST CONDITIONS:

Spoiler hinge moments occur as a function of surface rotation and air speed. Table B-II gives maximum and minimum cyclic hinge moment for the fatigue test. Spanwise unit running hinge moment curves are presented in Figure B-11.

TEST SETUP:

The specimen will be installed in the test jig as shown in Figure B-10. Air loads on the spoiler will be simulated by applying test loads through tension pads. Figure B-10 shows location of pads and applied load at each.

TEST PROCEDURE:

The spoiler fatigue spectrum is given in Table B-II. A cycle of load is from zero load to minimum load to maximum load to zero. Loads are given as airload hinge moments. The specimen will be tested to two lifetimes. Continuous recording of applied loads is required. Test data will be acquired from three (3) rosette strain gages and twelve (12) deflection devices as shown in Figure B-12.

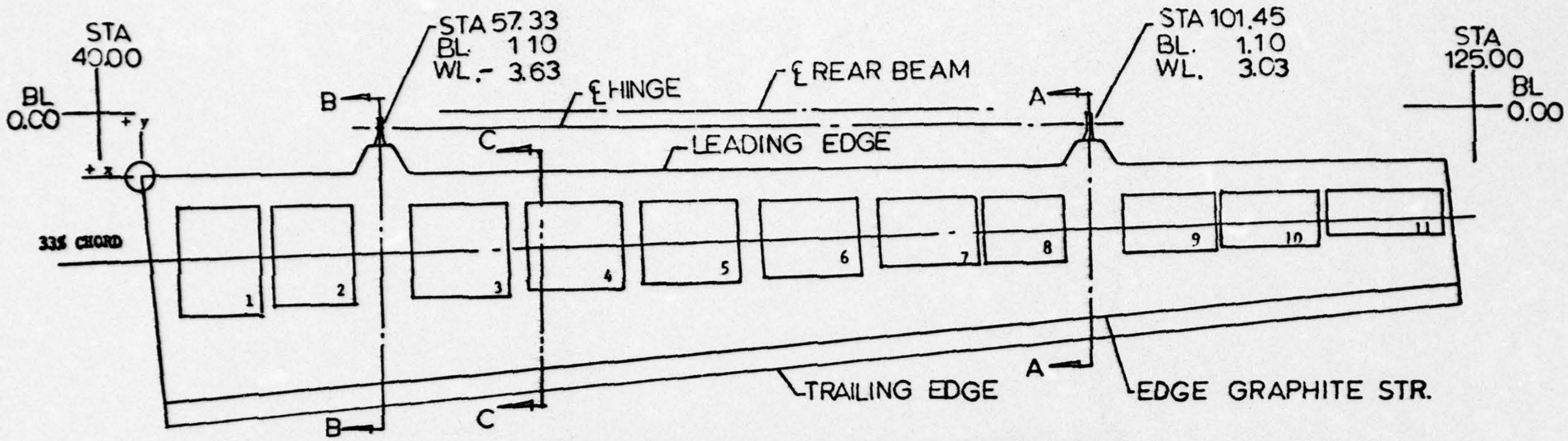
Strains will be reduced and plotted at end of each 1/4 life as a check on predicted stress values. Deflection data will also be checked. If a change in deflection rate or strain rate occurs, a check of structure for permanent set will be made.

METHOD OF LOAD APPLICATION:

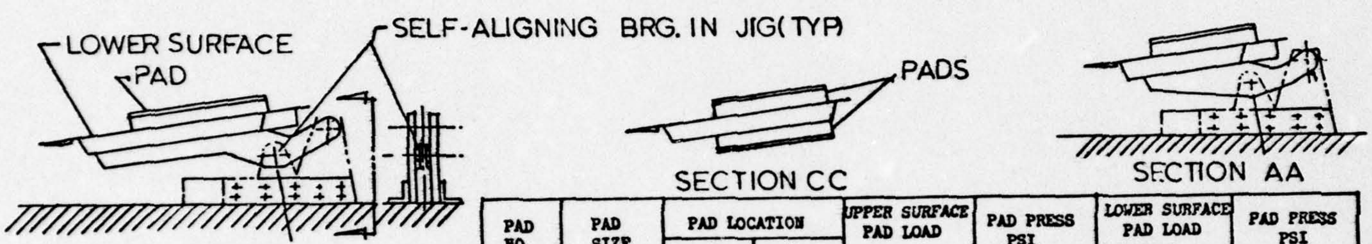
All loads will be applied to simulate as nearly as practicable the actual loads on the test article. Loads will be applied by rubber backed tension pads bonded to the surface. The test loads will be supplied to pads by means of hydraulic jacks.

MEASUREMENT OF STRUCTURAL DEFLECTIONS:

Structural deflections at spoiler and jig support points will be measured primarily by displacement devices supported by independent structures. The accuracy will be ±.02 inches defelction or better.



LOWER SPOILER (LOOKING AT OUTER SURFACE)



PAD NO.	PAD SIZE	PAD LOCATION		UPPER SURFACE PAD LOAD (TENSION)	PAD PRESS PSI	LOWER SURFACE PAD LOAD (TENSION)	PAD PRESS PSI
		X	Y				
1	5 x 6.4	7.38	8.20	274	8.56	137	4.28
2	5 x 6.2	12.90	7.80	215	6.94	108	3.48
3	6 x 5.8	22.32	7.45	213	6.12	107	3.07
4	6 x 5.3	29.56	6.90	213	6.70	107	3.36
5	6 x 4.9	36.79	6.50	193	6.56	96	3.26
6	6 x 4.6	44.03	6.20	193	7.00	96	3.48
7	6 x 4.3	51.26	5.80	178	6.90	89	3.45
8	5.3 x 4.0	57.00	5.68	137	6.46	69	3.25
9	5.6 x 3.6	66.50	5.15	127	6.30	63	3.12
10	6 x 3.1	72.97	4.70	158	8.50	79	4.25
11	5.8 x 2.8	79.25	4.3[illegible]	158	9.73	79	4.86

*Pad locations are given by locating the aft-otbd corner of pads.
X & Y are measured ∥ and ⊥ to spoiler leading edge beginning at fwd-inbd surface corner.

NOTES:

1. Pads located ∥ and ⊥ to spoiler leading edge.
2. Measurements are positive otbd and aft.
3. All measurements are to be made on skin outside surface.
4. Pad pulloffs are to be located at the geometric center of each pad.
5. Pad pulloffs located on spoiler 33% chord (for engineering reference only).
6. Loads shown are maximum.

FIGURE B-12 LOWER L. H. SPOILER FATIGUE TEST SET-UP AND LOAD REQUIREMENTS

TABLE B-II FATIGUE LOAD

CONDITION	CYCLES/LIFE	TEST LOAD (LB)	TEST H.M. (IN-LB)
COMPRESSION UPPER SURFACE	20,000**	2059*	14,160 (Maximum) *
TENSION UPPER SURFACE		-1030*	-7,080 (Minimum) *

* includes 1.18 increase in loads because of outboard upper spoiler deactivation- ECP 128

**one lifetime

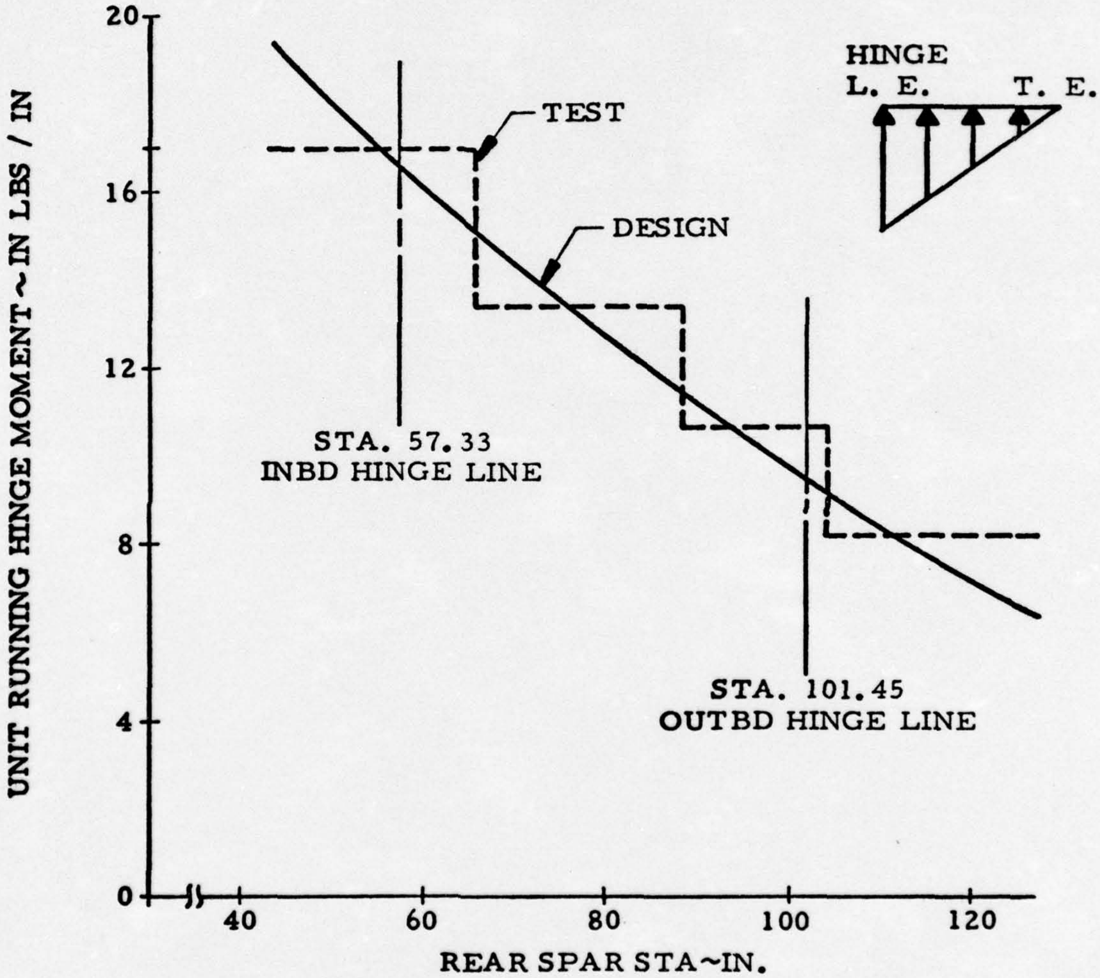
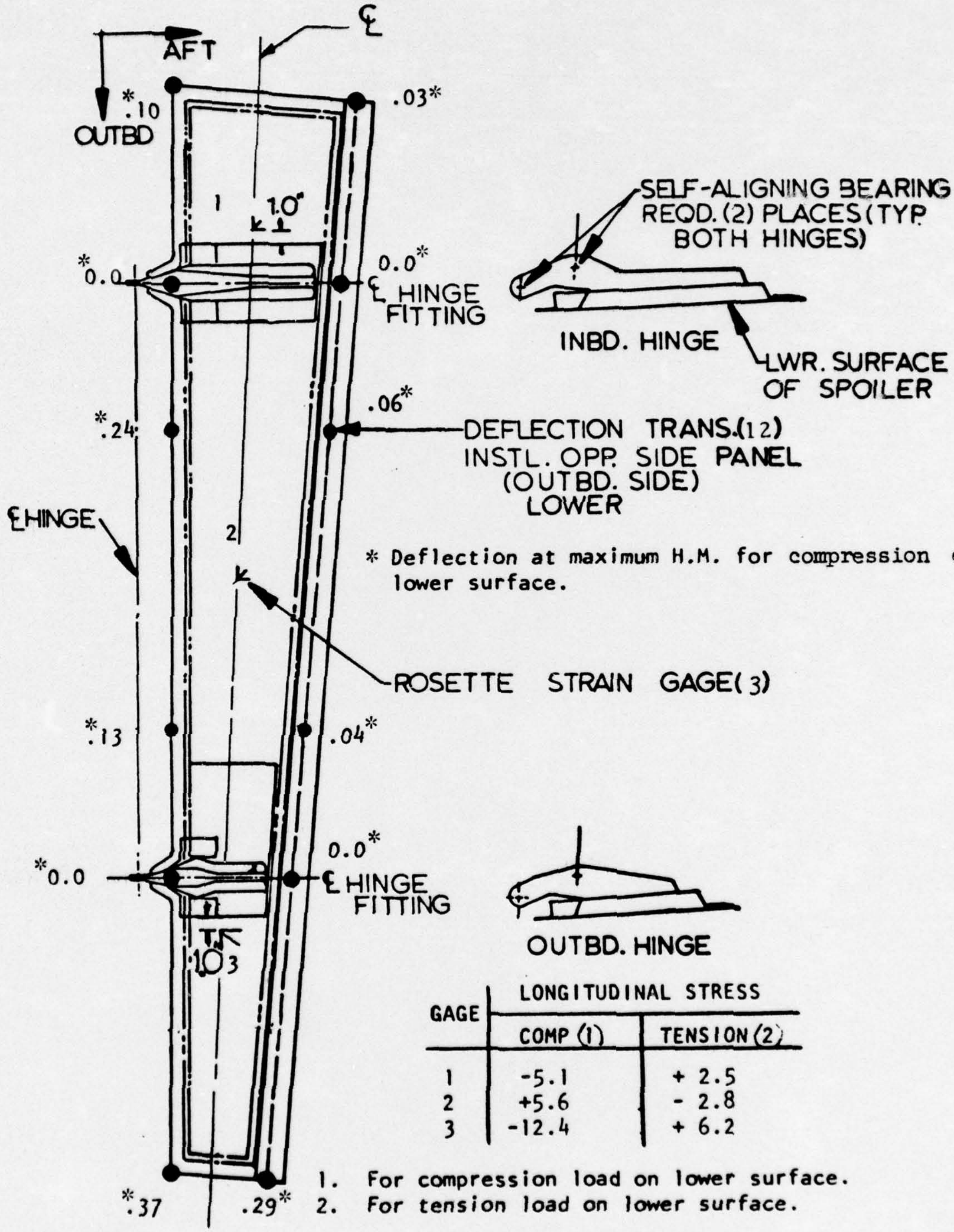


FIGURE B-13 S-3A COMPOSITE SPOILER SPANWISE RUNNING LOAD FOR A TOTAL SURFACE HINGE MOMENT OF 1000 IN - LBS APPLIED (FATIGUE CONDITION)



* Deflection at maximum H.M. for compression on lower surface.

GAGE	LONGITUDINAL STRESS	
	COMP (1)	TENSION (2)
1	-5.1	+ 2.5
2	+5.6	- 2.8
3	-12.4	+ 6.2

1. For compression load on lower surface.
2. For tension load on lower surface.

FIGURE B-14 DEFLECTION AND STRAIN GAGE LOCATION

NAVAL AIR DEVELOPMENT CENTER
AIR VEHICLE TECHNOLOGY DEPARTMENT
WARMINSTER, PA. 18974

3033

SUMMARY REPORT ON FATIGUE TEST RESULTS
FOR THE S-3A GRAPHITE SPOILER NUMBER 4

Ref: (a) LTV Report No. 2-53440/3R-10109 "Fatigue Test Plan S-3A Composite Spoiler", Revised 17 Jun 1974
(b) NAVAIRDEVCEN ltr report "Summary Report on Static Test Results for the S-3A Graphite Spoiler Number 1" dtd 30 May 1974

Table: (1) Fatigue Test Data -- Strain and Deflection

Figure B-15 Photograph No. CAD 20806-12-74-Test Set-up
Figure B-16 Photograph No. CAD 20805-12-74-Delamination Observed After 4800 Cycles
Figure B-17 Photograph No. CAD 20732-12-74-Outboard Fittings Failure
Figure (4) Photograph No. CAD 20829-12-74-Failure of Spoiler at 330 Percent DLL (Not Included in this Appendix)

1. The fatigue test was performed as described in reference (a). Loading consisted of constant amplitude cycling at the fatigue design loads shown in reference (a) for both the opening and closing conditions. Strain and deflection data were recorded periodically, and areas around the hinges were inspected at the same time with the Navy Ultrasonic Flow Detector AM/GSM 238. The spoiler sustained two equivalent lifetimes (40,000 cycles) of cyclic loading with no detectable damage. Strain and deflection data were monitored during the fatigue test and data for locations of interest are presented in Table III. The data indicated no significant changes in strain or deflection during the fatigue test.

2. Having satisfied the design requirements for fatigue with no detectable damage to the spoiler, the loads were increased to 150 percent DLL for the opening condition and 177 percent DLL for the closing condition and cycling was continued for an additional 40,000 cycles. The test setup was modified slightly after 4800 cycles to prevent unbonding of the tension pads and allow access to the areas around the hinges for ultrasonic inspection. With this modification, the applied loads were transferred from tension through the pads to compression on the opposite surface through aluminum channels shown in Figure B-15. During inspection at 4800 cycles, a slight delamination about 1.5 inches long was detected about 7 inches outboard of the outboard fitting shown in Figure B-16. Delamination appeared to be confined to the outer layer and did not increase in length during subsequent cycling.

Enclosure (3)

3. At approximately 22,000 cycles, failure of the inboard fitting occurred as shown in Figure B-17. The fitting was removed and replaced with the fitting from spoiler 3 and cycling was continued to 40,000 cycles without further incident. The data indicated no significant changes in strain or deflection during cycling at the higher loads as shown in Table III.

4. Static test to failure was accomplished after completion of the fatigue test. The spoiler was loaded in the closing condition in 20 percent DLL increments to 200 percent then in 10 percent increments to 330 percent DLL when failure suddenly occurred with no noticeable sound emissions prior to failure. The failure occurred approximately 4 inches outboard of the outboard hinge fitting as shown in Figure 4.

TABLE B-III FATIGUE TEST DATA --- STRAIN AND DEFLECTION

Gage No.	Design Fatigue Loads Measurement After Cycle No.			Channel No.	Design Ultimate Loads Measurement After Cycle No.		
	1	20000	40000		1	25000	40000
	Strain (-μ/in.)				Strain (-μ/in.)		
0	-310	-320	-323	0	-730	-695	-717
3	+561	+545	+562	3	+1300	+1334	+1322
6	-931	-915	-938	6	-2147	-2154	-2216
				DEFLECTION (IN.)			
83	-.040	-.024	-.022	83	-.057	-.049	-.082
88	-.126	-.127	-.129	88	-.279	-.256	-.304
89	-.217	-.221	-.292	89	-.651	-.654	-.699
95	-.140	-.169	-.159	95	-.344	-.340	-.360
96	-.342	-.339	-.335	96	-.729	-.722	-.781

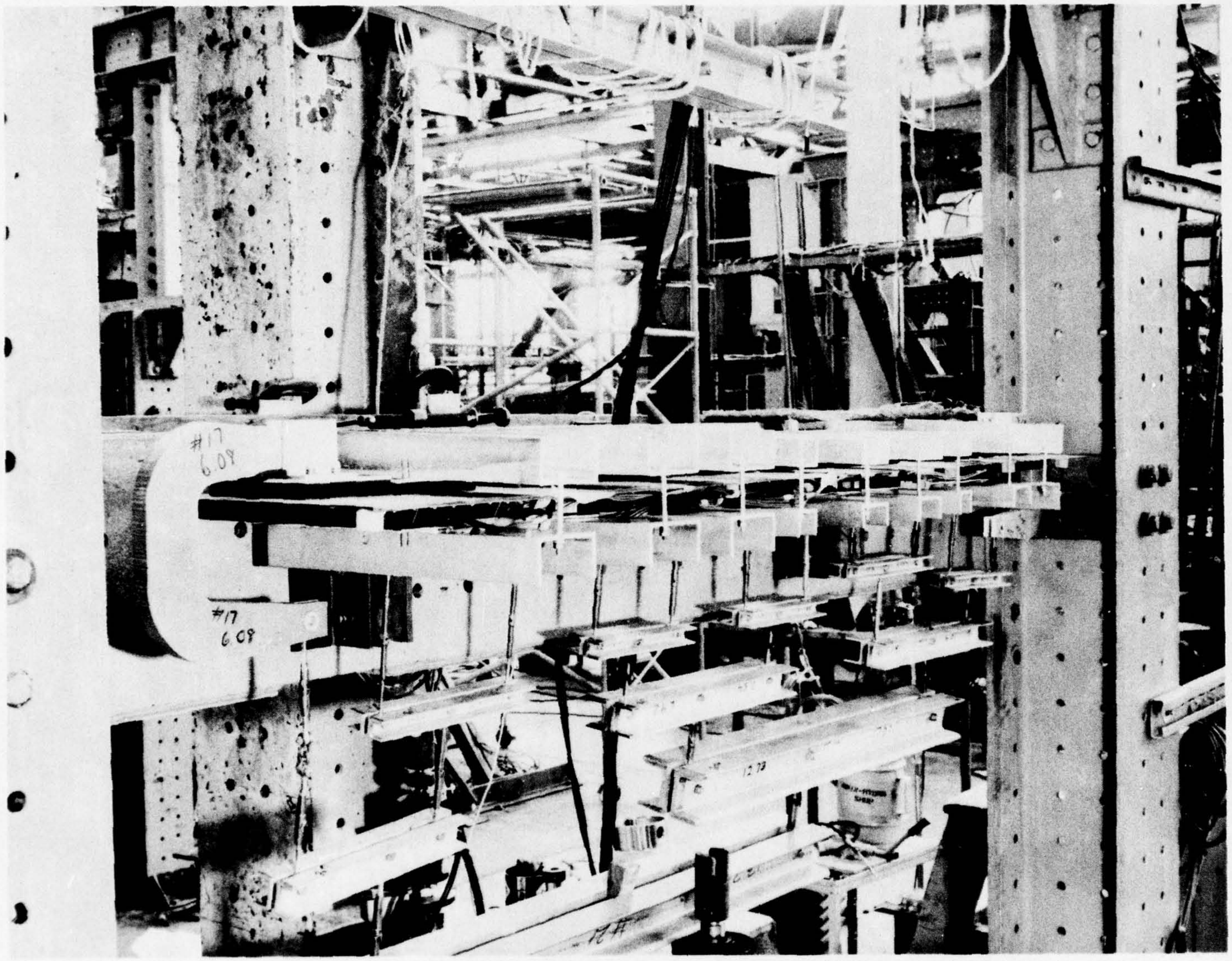


FIGURE B-15 SPOILER NO. 4 --- FATIGUE TEST SET-UP

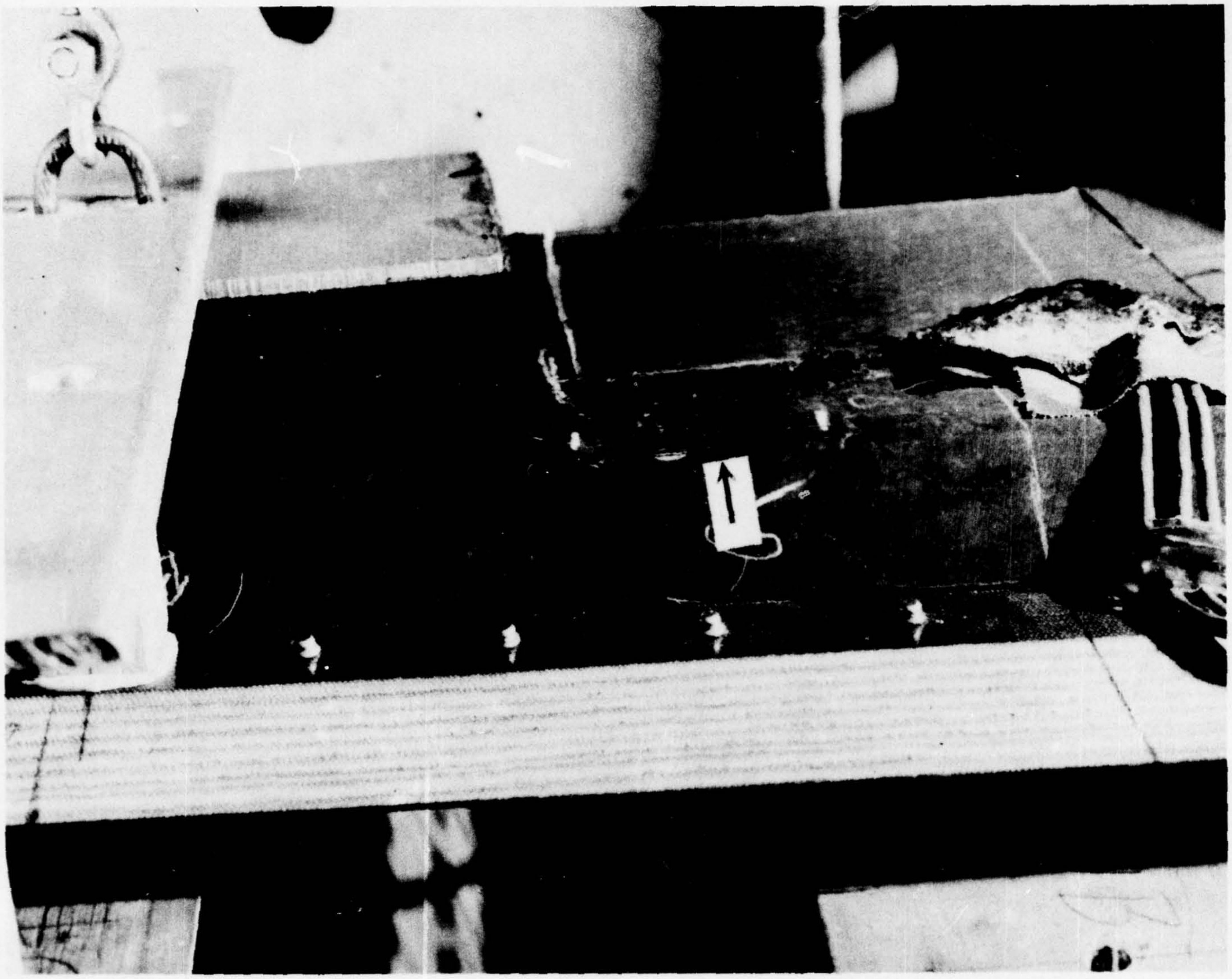


FIGURE B-16 SPOILER NO. 4 --- DELAMINATIONS (POST 4,800 CYCLES)

FIGURE B-17 SPOILER NO. 4 --- OUTBOARD FITTING FAILURE

FATIGUE 1st CYCLE DLL
OPENING CONDITION

0%			20%			60%			100%		
099	-10245	0	099	-14528	0	099	-15841	0	099	-17747	0
098	-00025	0	098	-00028	0	098	-00028	0	098	-00028	0
097	-00017	0	097	-00020	0	097	-00018	0	097	-00017	0
096	+00016	0	096	+00042	0	096	+00148	0	096	+00250	0
095	-00055	0	095	-00040	0	095	+00031	0	095	+00093	0
094	-00028	0	094	-00021	0	094	+00038	0	094	+00080	0
093	-00220	0	093	-00197	0	093	-00116	0	093	-00059	0
092	-00174	0	092	-00138	0	092	-00047	0	092	+00011	0
091	-00083	0	091	-00053	0	091	+00020	0	091	+00060	0
090	-00054	0	090	-00020	0	090	+00055	0	090	+00097	0
089	-00005	0	089	+00006	0	089	+00064	0	089	+00124	0
088	-00008	0	088	-00001	0	088	+00039	0	088	+00078	0
087	-00018	0	087	-00020	0	087	-00043	0	087	-00064	0
086	-00046	0	086	-00038	0	086	+00012	0	086	+00048	0
085	-00020	0	085	-00012	0	085	+00018	0	085	+00043	0
084	-00073	0	084	-00074	0	084	-00097	0	084	-00106	0
083	+00025	0	083	+00009	0	083	+00040	0	083	+00039	0
082	+12485	0	082	+13572	0	082	500000	0	082	500000	0
081	500000	0	081	+00015	0	081	+01186	0	081	+00044	0
080	500000	0	080	-100[illegible]	0	080	-14712	0	080	-09794	0
009	200000	0	009	2000[illegible]	0	009	200000	0	009	200000	0
008	+00002	0	008	-00039	0	008	-00113	0	008	-00187	0
007	-00005	0	007	+00015	0	007	+00067	0	007	+00119	0
006	-00011	0	006	+00075	0	006	+00243	0	006	+00414	0
005	-00005	0	005	+00004	0	005	+00018	0	005	+00029	0
004	-00009	0	004	-00019	0	004	-00060	0	004	-00107	0
003	+00010	0	003	-00044	0	003	-00153	0	003	-00258	0
002	+00004	0	002	-00008	0	002	-00030	0	002	-00049	0
001	-00003	0	001	-00005	0	001	-00010	0	001	-00019	0
000	-00006	0	000	+00020	0	000	+00000	0	000	+00139	0

FATIGUE 1st CYCLE DLL
CLOSING CONDITION

0%			20%			60%			100%		
099	-14923	0	099	-13453	0	099	-15561	0	099	-17340	0
098	-00025	0	098	-00032	0	098	-00034	0	098	-00035	0
097	-00015	0	097	-00015	0	097	-00010	0	097	-00007	0
096	+00002	0	096	-00074	0	096	-00203	0	096	-00340	0
095	-00074	0	095	-00112	0	095	-00184	0	095	-00248	0
094	-00058	0	094	-00077	0	094	-00114	0	094	-00146	0
093	-00254	0	093	-00348	0	093	-00383	0	093	-00461	0
092	-00205	0	092	-00260	0	092	-00361	0	092	-00454	0
091	-00114	0	091	-00163	0	091	-00230	0	091	-02288	0
090	-00084	0	090	-00136	0	090	-00198	0	090	-00258	0
089	-00001	0	089	-00049	0	089	-00134	0	089	-00218	0
088	-00017	0	088	-00041	0	088	-00093	0	088	-00143	0
087	-00008	0	087	-00014	0	087	+00004	0	087	+00006	0
086	-00062	0	086	-00098	0	086	-00163	0	086	-00230	0
085	-00029	0	085	-00053	0	085	-00102	0	085	-00149	0
084	-00067	0	084	-00061	0	084	-00051	0	084	-00045	0
083	-00012	0	083	-00017	0	083	-00048	0	083	-00052	0
082	+13791	0	082	+15408	0	082	500000	0	082	500000	0
081	500000	0	081	+04572	0	081	+00033	0	081	+00006	0
080	500000	0	080	-13910	0	080	-10980	0	080	-10473	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	-00018	0	008	+00067	0	008	+00223	0	008	+00382	0
007	+00000	0	007	-00050	0	007	-00150	0	007	-00259	0
006	+00024	0	006	-00165	0	006	-00527	0	006	-00907	0
005	-00008	0	005	-00026	0	005	-00066	0	005	-00111	0
004	-00013	0	004	+00012	0	004	+00071	0	004	+00134	0
003	+00002	0	003	+00109	0	003	+00334	0	003	+00563	0
002	-00001	0	002	+00021	0	002	+00059	0	002	+00095	0
001	-00007	0	001	-00002	0	001	+00007	0	001	+00017	0
000	+00002	0	000	-00061	0	000	-00184	0	000	-00312	0

FATIGUE 20K CYCLES DLL
OPENING CONDITION

0%			20%			60%			100%		
099	-15447	0				099	-17583	0	099	-17471	0
098	-00005	0	099	-15842	0	098	-00012	0	098	-00013	
097	-00007	0	098	-00013	0	097	-00013	0	097	-00011	0
096	-00003	0	097	-00011	0	096	+00097	0	096	+00167	0
095	+00003	0	096	+00018	0	095	+00053	0	095	+00086	0
094	-00012	0	095	+00008	0	094	+00018	0	094	+00031	0
093	-00007	0	094	-00014	0	093	+00043	0	093	+00077	0
092	-00006	0	093	-00000	0	092	+00044	0	092	+00086	0
091	-00002	0	092	-00001	0	091	+00031	0	091	+00056	0
090	+00003	0	091	+00002	0	090	+00031	0	090	+00055	0
089	-00002	0	089	+00000	0	089	+00059	0	089	+00097	0
088	-00003	0	088	+00003	0	088	+00027	0	088	+00052	0
087	+0000[illegible]	0	087	-00001	0	087	-00010	0	087	-00021	0
086	-00007	0	086	-00003	0	086	+00022	0	086	+00048	0
085	+00000	0	085	-00006	0	085	+90008	0	085	+00027	0
084	-00005	0	084	-00010	0	084	-00014	0	084	-00022	0
083	-00005	0	083	-00006	0	083	-00006	0	083	-00003	0
082	200000	0	082	500000	0	082	500000	0	082	500000	0
081	200000	0	081	500000	0	081	+01207	0	081	+00935	0
080	200000	0	080	+07119	0	080	-17160	0	080	-20182	0
009	200000	0	009	2[illegible]	0	009	200000	0	009	200000	0
008	+00002	0	008	-0[illegible]033	0	008	-00104	0	008	-00172	0
007	-00007	0	007	+00014	0	007	+00063	0	007	+00107	0
006	-00010	0	006	+00067	0	006	+00233	0	006	+00385	0
005	+00001	0	005	+00007	0	005	+00019	0	005	+00031	0
004	-00009	0	004	-00024	0	004	-00077	0	004	-00114	0
003	+00002	0	003	-00047	0	003	-00153	0	003	-00249	0
002	-00004	0	002	-00015	0	002	-00035	0	002	-00056	0
001	-00007	0	001	-00010	0	001	-00023	0	001	-00030	0
000	+00002	0	000	+00027	0	000	+00080	0	000	+00141	0

FATIGUE 20K CYCLES DLL
CLOSING CONDITION

0%			20%			60%			100%		
099	-15018	0	099	-15634	0	099	-20197	0	099	-16875	0
098	-00015	0	098	-00015	0	098	-00011	0	098	-00014	0
097	-00015	0	097	-00016	0	097	-00009	0	097	-00014	0
096	-00015	0	096	-00088	0	096	-00224	0	096	-00354	0
095	-00006	0	095	-00048	0	095	-00111	0	095	-00175	0
094	-00019	0	094	-00038	0	094	-00068	0	094	-00093	0
093	-00018	0	093	-00056	0	093	-00128	0	093	-00197	0
092	-00017	0	092	-00067	0	092	-00158	0	092	-00231	0
091	-00011	0	091	-00032	0	091	-00085	0	091	-00132	0
090	-00005	0	090	-00033	0	090	-00084	0	090	-00123	0
089	-00012	0	089	-00060	0	089	-00154	0	089	-00233	0
088	-00010	0	088	-00042	0	088	-00092	0	088	-00137	0
087	-00017	0	087	-00017	0	087	-00010	0	087	-00008	0
086	-00018	0	086	-00053	0	086	-00117	0	086	-00178	0
085	-00011	0	085	-00035	0	085	-00079	0	085	-00125	0
084	-00016	0	084	-00010	0	084	-00011	0	084	-00011	0
083	-00011	0	083	-00011	0	083	-00025	0	083	-00035	0
082	500000	0	082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	+11747	0	081	+05213	0	081	+04098	0
080	-10064	0	080	-08816	0	080	-21056	0	080	-21037	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	+00004	0	008	+00088	0	008	+00237	0	008	+00390	0
007	-00011	0	007	-00066	0	007	-00172	0	007	-00279	0
006	-00010	0	006	-00195	0	006	-00562	0	006	-00925	0
005	-00002	0	005	-00020	0	005	-00059	0	005	-00104	0
004	-00017	0	004	+00027	0	004	+00093	0	004	+00156	0
003	-00002	0	003	+00106	0	003	+00322	0	003	+00543	0
002	-00006	0	002	+00016	0	002	+00055	0	002	+00090	0
001	-00009	0	001	-00003	0	001	+00009	0	001	+00021	0
000	-00001	0	000	-00065	0	000	-00173	0	000	-00321	0

FATIGUE 40K CYCLES DLL
OPENING CONDITION

0%			20%			60%			100%		
099	-19420	0	099	-19204	0	099	-19900	0	099	-21122	0
098	-00017	0	098	-00025	0	098	-00026	0	098	-00027	0
097	+00010	0	097	+00003	0	097	+00003	0	097	+00002	0
096	-00018	0	096	-00004	0	096	+00065	0	096	+00158	0
095	-00030	0	095	-00025	0	095	+00019	0	095	+00064	0
094	-00021	0	094	-00025	0	094	+00000	0	094	+00028	0
093	-00050	0	093	-00039	0	093	+00002	0	093	+00048	0
092	-00058	0	092	-00055	0	092	+79988	0	092	+00038	0
091	-00075	0	091	-00061	0	091	-00037	0	091	-00008	0
090	-00040	0	090	-00026	0	090	-00007	0	090	+00020	0
089	+00008	0	089	+00030	0	089	+00094	0	089	+00152	0
088	-00028	0	088	-00026	0	088	+00005	0	088	+00029	0
087	+00032	0	087	+00026	0	087	+00022	0	087	+00005	0
086	-00044	0	086	-00043	0	086	-00015	0	086	+00012	0
085	-00018	0	085	-00017	0	085	+80009	0	085	+00046	0
084	-00028	0	084	-00033	0	084	-00033	0	084	-00039	0
083	-00012	0	083	-00018	0	083	-00017	0	083	-00013	0
082	500000	0	082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0	080	500000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	-00004	0	008	-00042	0	008	-00113	0	008	-00186	0
007	+00003	0	007	+00027	0	007	+00075	0	007	+00126	0
006	-00006	0	006	+00081	0	006	+00240	0	006	+00406	0
005	-00001	0	005	+00004	0	005	+00016	0	005	+00031	0
004	-00007	0	004	-00027	0	004	-00076	0	004	-00123	0
003	+00003	0	003	-00047	0	003	-00149	0	003	-00255	0
002	+00001	0	002	-00006	0	002	-00028	0	002	-00040	0
001	-00003	0	001	-00005	0	001	-00017	0	001	-00026	0
000	+00007	0	000	+00035	0	000	+00092	0	000	+00149	0

FATIGUE 40K CYCLES DLL
CLOSING CONDITION

0%			20%			60%			100%		
099	-17353	0	099	-16976	0	099	-17739	0	099	-15745	0
098	-00027	0	098	-00028	0	098	-00029	0	098	-00023	0
097	+00001	0	097	-00002	0	097	-00004	0	097	-00002	0
096	-00017	0	096	-00095	0	096	-00227	0	096	-00352	0
095	+79971	0	095	-00070	0	095	-00134	0	095	-00192	0
094	-00018	0	094	-00039	0	094	-00069	0	094	-00091	0
093	-00045	0	093	-00086	0	093	-00157	0	093	-00223	0
092	-00058	0	092	-00112	0	092	-00194	0	092	-00272	0
091	-00065	0	091	-00092	0	091	-00134	0	091	-00175	0
090	-00028	0	090	-00055	0	090	-00100	0	090	-00136	0
089	+00009	0	089	-00072	0	089	-00182	0	089	-00304	0
088	-00031	0	088	-00063	0	088	-00112	0	088	-00160	0
087	+00009	0	087	+00003	0	087	+00012	0	087	+00017	0
086	-00048	0	086	-00086	0	086	-00146	0	086	-00206	0
085	-00013	0	085	-00054	0	085	-00126	0	085	-00197	0
084	-00041	0	084	-00040	0	084	-00037	0	084	-00028	0
083	-00021	0	083	-00026	0	083	-00039	0	083	-00043	0
082	500000	0	082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0	080	500000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	-00006	0	008	+00081	0	008	+00238	0	008	+00389	0
007	+00003	0	007	-00055	0	007	-00156	0	007	-00257	0
006	-00004	0	006	-00204	0	006	-00571	0	006	-00934	0
005	-00002	0	005	-00024	0	005	-00066	0	005	-00110	0
004	-00013	0	004	+00024	0	004	+00090	0	004	+00154	0
003	-00002	0	003	+00121	0	003	+00341	0	003	+00560	0
002	+00000	0	002	+00021	0	002	+00058	0	002	+00093	0
001	-00005	0	001	+00004	0	001	+00013	0	001	+00024	0
000	+00007	0	000	-00064	0	000	-00192	0	000	-00316	0

FATIGUE 1st CYCLE 150% DLL
OPENING CONDITION

0%			20%			60%			100%		
099	-15151	0	099	-20048	0	099	-20177	0	099	-14995	0
098	-00017	0	098	-00026	0	098	-00024	0	098	-00026	0
097	+00040	0	097	+00032	0	097	+00023	0	097	+00017	0
096	-00017	0	096	+00023	0	096	+00133	0	096	+00208	0
095	-00030	0	095	-00013	0	095	+00051	0	095	+00089	0
094	-00010	0	094	-00011	0	094	+00025	0	094	+00042	0
093	-00071	0	093	-00052	0	093	+00006	0	093	+00045	0
092	-00096	0	092	-00074	0	092	+00001	0	092	+00035	0
091	-00112	0	091	-00103	0	091	-00061	0	091	-00025	0
090	-00055	0	090	-00044	0	090	-00008	0	090	+00021	0
089	+00050	0	089	+00071	0	089	+00138	0	089	+00197	0
088	-00026	0	088	-00018	0	088	+00017	0	088	+00043	0
087	+00059	0	087	+00047	0	087	+00028	0	087	+00014	0
086	-00044	0	086	-00039	0	086	-00003	0	086	+00026	0
085	-00004	0	085	-00008	0	085	+00031	0	085	+00063	0
084	-00027	0	084	-00030	0	084	-00040	0	084	-00050	0
083	-00018	0	083	-00010	0	083	-00018	0	083	-00015	0
082	500000	0	082	500000	0	082	500000	0	082	500000	0
081	500000	0	081	500000	0	081	500000	0	081	500000	0
080	500000	0	080	500000	0	080	500000	0	080	500000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	+00002	0	008	-00046	0	008	-00136	0	008	-00222	0
007	+00005	0	007	+00038	0	007	+00102	0	007	+00158	0
006	-00001	0	006	+00111	0	006	+00315	0	006	+00508	0
005	+00003	0	005	+00011	0	005	+00028	0	005	+00043	0
004	+00004	0	004	-00019	0	004	-00087	0	004	-00132	0
003	+00001	0	003	-00065	0	003	-00194	0	003	-00318	0
002	+0000[illegible]	[illegible]	002	-00005	0	002	-00029	0	002	-00054	0
001	-00002	0	001	-00005	0	001	-00021	0	001	-00031	0
[illegible]	[illegible]	0	000	+00041	0	000	+00114	0	000	+00182	0

FATIGUE 1st CYCLE 177% DLL
CLOSING CONDITION

0%			20%			60%			100%		
099	-19012	0	099	-06900	0	099	-12365	0	099	-20961	0
098	-00028	0	098	+00022	0	098	+00011	0	098	+00006	0
097	+00017	0	097	+00057	0	097	+00050	0	097	+00033	0
096	-00001	0	096	-00110	0	096	-00428	0	096	-00737	0
095	-00017	0	095	-00051	0	095	-00209	0	095	-00363	0
094	-00013	0	094	-00011	0	094	-00080	0	094	-00157	0
093	-00057	0	093	-00101	0	093	-00279	0	093	-00465	0
092	-00077	0	092	-00130.	0	092	-00334	0	092	-00563	0
091	-00096	0	091	-00123	0	091	-00220	0	091	-00379	0
090	-00040	0	090	-00053	0	090	-00154	0	090	-00303	0
089	+00024	0	089	-00075	0	089	-00355	0	089	-00042	0
088	-00026	0	088	-00046.	0	088	-00165	0	088	-00293	0
087	+00012	0	087	+00056	0	087	+00056	0	087	+00059	0
086	-00050	0	086	-00079	0	086	-00231	0	086	-00394	0
085	-00012	0	085	-00054	0	085	-00218	0	085	-00406	0
084	-00041	0	084	-00006	0	084	+00011	0	084	+00015	0
083	-00015	0	083	+00004	0	083	-00034	0	083	+00073	0
082	500000	0	082	200000	0	082	500000	0	082	500000	0
081	500000	0	081	200000	0	081	500000	0	081	500000	0
080	500000	0	080	200000	0	080	500000	0	080	500000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	-00002	0	008	+00177	0	008	+00535	0	006	+00070	0
007	+00009	0	007	-00106	0	007	-00349	0	007	-00012	0
006	+00010	0	006	-00404	0	006	-01270	0	006	-02147	0
005	+00005	0	005	-00043	0	005	-00148	0	005	-00276	0
004	-00004	0	004	+00078	0	004	+00230	0	004	+00342	0
003	-00005	0	003	+00248	0	003	+00770	0	003	+01300	0
002	+00011	0	002	+00050	0	002	+00140	0	002	+00218	0
001	-00002	0	001	+00013	0	001	+00038	0	001	+00057	0
000	+00005	0	000	-00140	0	000	-00439	0	000	-00730	0

FATIGUE 25K CYCLES 150% DLL
OPENING CONDITION

0%			20%			60%			100%		
099	+02159	0	099	-07689	0	099	-04457	0	099	-04252	0
098	-00014	0	098	-00020	0	098	-00020	0	098	-00026	0
097	-00013	0	097	-00014	0	097	-00018	0	097	-00022	0
096	+00000	0	096	+00040	0	096	+00107	0	096	+00169	0
095	-00011	0	095	-00002	0	095	+00026	0	095	+00059	0
094	-00007	0	094	-00007	0	094	+00002	0	094	+00015	0
093	+00005	0	093	+00010	0	093	+00049	0	093	+00091	0
092	-00006	0	092	+00010	0	092	+00055	0	092	+00101	0
091	-00002	0	091	-00000	0	091	+00033	0	091	+00057	0
090	-00006	0	090	-00001	0	090	+00030	0	090	+00065	0
089	-00006	0	089	+00022	0	089	+00081	0	089	+00138	0
088	+00001	0	088	-00001	0	088	+00027	0	088	+00049	0
087	+00005	0	087	-00006	0	087	-00003	0	087	-00013	0
086	+00005	0	086	+00013	0	086	+00052	0	086	+00077	0
085	+00014	0	085	+00011	0	085	+00047	0	085	+00081	0
084	-00006	0	084	-00006	0	084	-00010	0	084	-00019	0
083	+00009	0	083	+00011	0	083	+00005	0	083	+00015	0
082	200000	0	082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	20[illegible]000	0	080	200000	0	080	2[illegible]000	0
009	200000	0	009	200000	0	009	200000	0	009	20[illegible]000	0
008	-00006	0	008	-00056	0	008	-00142	0	008	-00225	0
007	+00006	0	007	+00037	0	007	+00095	0	007	+00148	0
006	-00003	0	006	+00110	0	006	+00312	0	006	+00502	0
005	-00006	0	005	+00004	0	005	+00025	0	005	+00041	0
004	-00001	0	004	-00022	0	004	-00063	0	004	-00096	0
003	+00005	0	003	-00070	0	003	-00204	0	003	-00331	0
002	+00008	0	002	-00008	0	002	-00032	0	002	-00053	0
001	-00000	0	001	-00005	0	001	-00013	0	001	-00019	0
000	+00018	0	000	+00048	0	000	+00120	0	000	+00187	0

FATIGUE 25K CYCLES 177% DLL
CLOSING CONDITION

0%			20%			60%			100%		
099	-09473	0	099	-03060	0	099	-04930	0	099	-04954	0
098	-00025	0	098	-00026	0	098	-00026	0	098	-00021	0
097	-00023	0	097	-00020	0	097	-00020	0	097	-00008	0
096	+00022	0	096	-00130	0	096	-00420	0	096	-00700	0
095	-00017	0	095	-00091	0	095	-00223	0	095	-00357	0
094	-00012	0	094	-00041	0	094	-00091	0	094	-00149	0
093	-00002	0	093	-00093	0	093	-00250	0	093	-00406	0
092	-00009	0	092	-00112	0	092	-00300	0	092	-00492	0
091	-00003	0	091	-00070	0	091	-00189	0	091	-00290	0
090	-00005	0	090	-00073	0	090	-00172	0	090	-00261	0
089	-00011	0	089	-00155	0	089	-00410	0	089	-00665	0
088	-00006	0	088	-00069	0	088	-00167	0	088	-00262	0
087	-00016	0	087	-00016	0	087	-00008	0	087	+00009	0
086	-00003	0	086	-00079	0	086	-00229	0	086	-00380	0
085	+00005	0	085	-00076	0	085	-00243	0	085	-00417	0
084	-00017	0	084	-00014	0	084	+00002	0	084	+00010	0
083	+00004	0	083	+00029	0	083	-00028	0	083	-00045	0
082	200000	0	082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200000	0	080	200000	0	080	200000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	-00011	0	008	+00171	0	008	+00516	0	008	+00850	0
007	+00006	0	007	-00120	0	007	-00366	0	007	-00637	0
006	+00005	0	006	-00432	0	006	-01280	0	006	-02154	0
005	-00006	0	005	-00053	0	005	-00158	0	005	-00283	0
004	+00000	0	004	+00074	0	004	+00217	0	004	+00360	0
003	-00004	0	003	+00273	0	003	+00802	0	003	+01334	0
002	+00009	0	002	+00053	0	002	+00134	0	002	+00206	0
001	+00001	0	001	+00016	0	001	+00044	0	001	+00070	0
000	+00010	0	000	-00136	0	000	-00414	0	000	-00695	0

STATIC TEST TO FAILURE
AFTER FATIGUE TEST

10%			40%			80%			120%			160%		
099	-02002	0	099	-03061	0	099	-04881	0	099	-04724	0	099	-03937	0
098	-00014	0	098	-00028	0	098	-00021	0	098	-00018	0	098	-00013	0
097	+00005	0	097	-00002	0	097	+00005	0	097	+00014	0	097	+00010	0
096	+00087	0	096	-00212	0	096	-00368	0	096	-00532	0	096	-00691	0
095	-00015	0	095	-00117	0	095	-00197	0	095	-00274	0	095	-00347	0
094	+00002	0	094	-00043	0	094	-00070	0	094	-00103	0	094	-00128	0
093	+00001	0	093	-00129	0	093	-00216	0	093	-00305	0	093	-00391	0
092	-00010	0	092	-00145	0	092	-00240	0	092	-00351	0	092	-00450	0
091	-00009	0	091	-00094	0	091	-00156	0	091	-00211	0	091	-00267	0
090	-00004	0	090	-00393	0	090	-00457	0	090	-00504	0	090	-00555	0
089	+00004	0	089	-00202	0	089	-00356	0	089	-00496	0	089	-00642	0
088	-00000	0	088	-00087	0	088	-00150	0	088	-00289	0	088	-00273	0
087	-00012	0	087	-00019	0	087	-00021	0	087	-00022	0	087	-00023	0
086	-00002	0	086	-00107	0	086	-00190	0	086	-00273	0	086	-00353	0
085	-00001	0	085	-00113	0	085	-00204	0	085	-00294	0	085	-00394	0
084	-00005	0	084	-00016	0	084	-00013	0	084	-00003	0	084	-00000	0
083	-00007	0	083	-00064	0	083	-00060	0	083	-00070	0	083	-00071	0
082	200000	0	082	200000	0	082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200003	0	080	200000	0	080	200000	0	080	200000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	+00004	0	008	+00247	0	008	+00450	0	008	+00647	0	008	+00828	0
007	+00009	0	007	-00159	0	007	-00300	0	007	-00450	0	007	-00595	0
006	+00007	0	006	-00562	0	006	-01044	0	006	-01544	0	006	-02010	0
005	-00006	0	005	-00058	0	005	-00113	0	005	-00177	0	005	-00241	0
004	+00000	0	004	+00090	0	004	+00168	0	004	+00252	0	004	+00330	0
003	-00010	0	003	+00324	0	003	+00615	0	003	+00922	0	003	+01200	0
002	+00008	0	002	+00062	0	002	+00107	0	002	+00155	0	002	+00197	0
001	-00000	0	001	+00010	0	001	+00027	0	001	+00042	0	001	+00057	0
000	-00000	0	000	-00192	0	000	-00348	0	000	-00508	0	000	-00659	0

STATIC TEST TO FAILURE
CONTINUED

200%			240%			280%			320%		
099	-00324	0	099	-00352	0	099	-04790	2	099	-03089	0
098	-00011	0	098	-00010	0	098	-00005	0	098	-00005	0
097	+00014	0	097	+00017	0	097	+00033	0	097	+00022	0
096	-00356	0	096	-01016	0	096	-01343	0	096	-01183	0
095	-00424	0	095	-00501	0	095	-00658	0	095	-00576	0
094	-00168	0	094	-00189	0	094	-00252	0	094	-00220	0
093	-00483	0	093	-00574	0	093	-00707	0	093	-00670	0
092	-00501	0	092	-00665	0	092	-00877	0	092	-00772	0
091	-00338	0	091	-00384	0	091	-00586	0	091	-00446	0
090	-00603	0	090	-00053	0	090	-00754	0	090	-00703	0
089	-00603	0	089	-00941	0	089	-01241	0	089	-01093	0
088	-00333	0	088	-00390	0	088	-00505	0	088	-00456	0
087	-00024	0	087	-00012	0	087	+00020	0	087	-00005	0
086	-00444	0	086	-00522	0	086	-00696	0	086	-00613	0
085	-00486	0	085	-00580	0	085	-00769	0	085	-00678	0
084	+00010	0	084	+00021	0	084	+00033	0	084	+00024	0
083	-00005	0	083	-00089	0	083	-00092	0	083	-00098	0
082	200000	0	082	200000	0	082	200000	0	082	200000	0
081	200000	0	081	200000	0	081	200000	0	081	200000	0
080	200000	0	080	200000	0	080	200000	0	080	200000	0
009	200000	0	009	200000	0	009	200000	0	009	200000	0
008	+01016	0	008	+01193	0	008	+01532	0	008	+01364	0
007	-00756	0	007	-00923	0	007	-01276	0	007	-01098	0
006	-02519	0	006	-03509	0	006	-03995	0	006	-03504	0
005	-00511	0	005	-00384	0	005	-00548	0	005	-00465	0
004	+00413	0	004	+00485	0	004	+00023	0	004	+00256	0
003	+01502	0	003	+01793	0	003	+02372	0	003	+02087	0
002	+00239	0	002	+00274	0	002	+00314	0	002	+00298	0
001	+00073	0	001	+00087	0	001	+00102	0	001	+00096	0
000	-00817	0	000	-00972	0	000	-01274	0	000	-01126	0

APPENDIX C

This section contains the final revised manufacturing plan for the fabrication of graphite/epoxy spoilers for the lower left hand surface of the S-3A outer wing panel.

MANUFACTURING PLAN
GRAPHITE/EPOXY S-3A SPOILER

I. Core Stabilization

A. Machine core segments to size

B. Sand .125 R per engineering drawing

C. Machine lower bevels

D. Clean core

1. Solvent flush
2. Dry (1 hr. @ R.T.)
3. Wrap in clean Kraft paper

E. Stabilize core

1. Stabilize periphery of core by dipping SC 1008 phenolic resin
2. Cure in oven (350F - 1 hr.)
3. Wrap in clean Kraft paper

II. Tab Stiffener Assembly (Separate Operation) For Four Spoilers

A. Prepare tool (flat plate) for bonding

1. Solvent clean
2. Apply release coating

B. From broadgoods

1. Lay up one (10 x 26) 4 ply laminate (per 78-002553)
2. Trim one piece HRP core, 5 x 26 inches

a. Saw 26 inch edges at 30° bevel
b. Clean core

(1) Solvent flush
(2) Dry (1 hr. @ R.T.)
(3) Wrap in clean Kraft paper

3. Trim film adhesive, specification 207-8-115, type II, grade 10 to match laminate

a. Apply adhesive
b. Remove backing film

4. Apply core to adhesive per engineering drawing

C. Prepare for cure (specification 208-8-3), apply:

1. Peel ply
2. Separator film
3. Bleeder
4. Vacuum bleeder
5. Breather
6. Bagging film

D. Autoclave cure

1. Door close to door open - 4 hrs.

E. Debag

F. Machine - 22 and 23, (4 each) (78-002553) from stock produced by B thru E above.

G. Clean -22 and -23

1. Solvent clean
2. Dry (160F for 1 hr.)
3. Wrap in clean Kraft paper

III. Lower Skin Assembly

A. Prepare tool for bonding

1. Solvent clean
2. Apply release film
3. Apply peel ply

B. Template trim 120 mesh screen to size

C. Clean screen (CVA 8-51, Method II)

1. Vapor degrease
2. Rinse
3. Alkaline clean
4. Rinse
5. Acid clean
6. Rinse
7. Protect (paper wrap)
8. After cleaning handle screen only when using cotton gloves

D. Apply screen in molding tool

E. Apply film adhesive, specification 207-8-415, type II, grade 10

1. Template trim
2. Place on assembly
3. Remove backing film

F. Hand lay up lower skin

1. Trim plies number 1 thru 9 (one template) (Ref. Figure C1)
2. Place lower skin on tool (use transfer template)

a. Remove mylar backing

G. From broadgoods (38 x 90 - 45° orientation)

1. Trim ply numbers 10 thru 18 (17 templates) (Ref. Figures C2 thru C6)
2. Apply plies, in proper sequence, on tool

a. Remove Mylar backing

IV. Lower Skin/Core Subassembly

A. Apply film adhesives, specification 207-8-415, type II, grade 10, to lower skin to core faying surface

1. Remove backing film

B. Place core segments onto lower skin

1. Use adhesive foam specification 207-8-408, type III, for core splice (2 places)

C. Apply film adhesive, specification 207-8-415, type II, grade 10 to upper surface of core

1. Remove backing film

V. Upper Skin Assembly

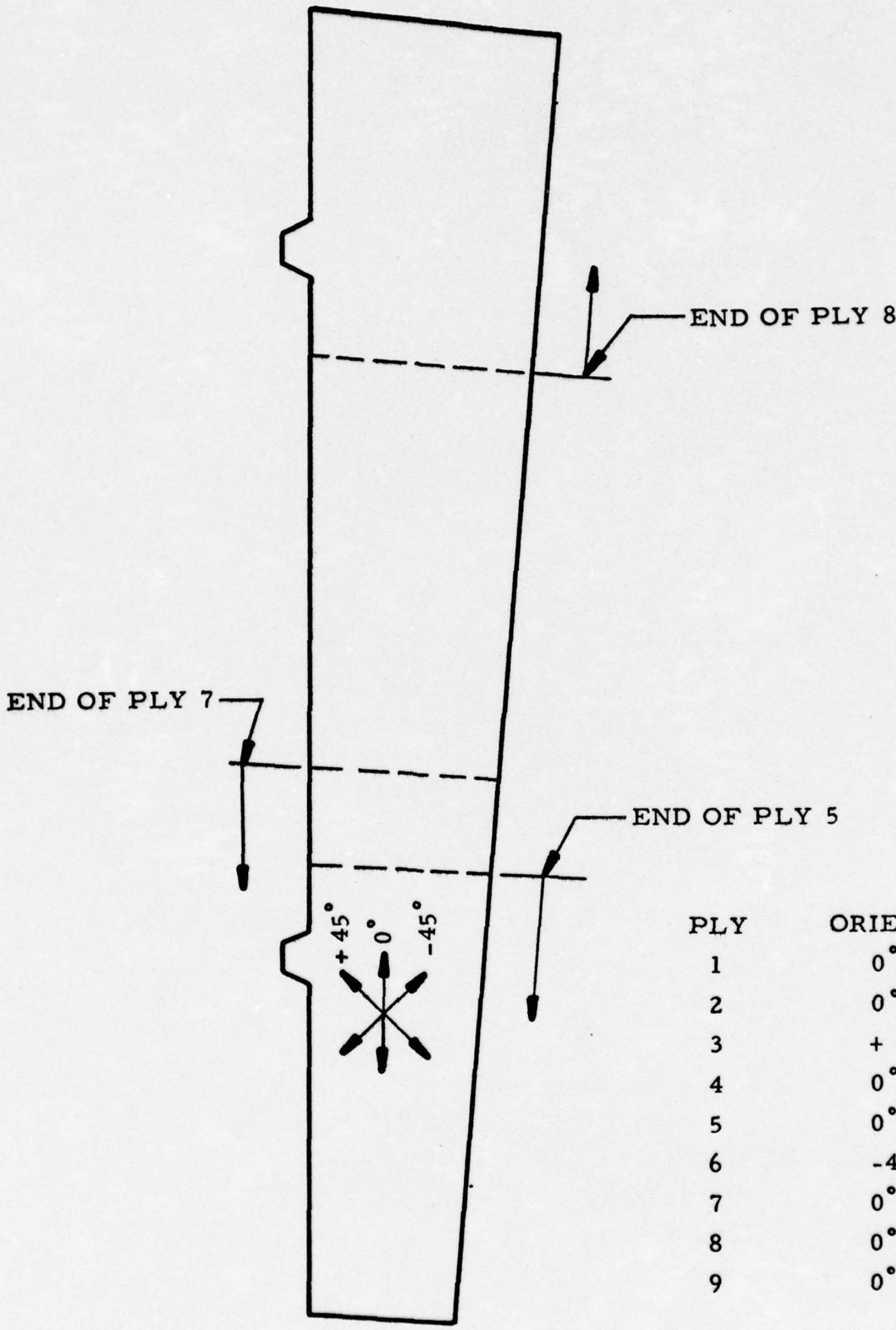
A. Hand lay up upper skin

1. Trim ply numbers 1 thru 9 (one template) (Ref Figure C7)
2. Trim plies for upper skin doublers (three templates)
3. Apply to tool (use transfer template) butt joint corners per engineering drawing 78-002553
4. Apply upper skin doubler ply stack on upper skin (use transfer template) (Ref Figure C8)
5. Protect from contamination

VI. Spoiler Assembly

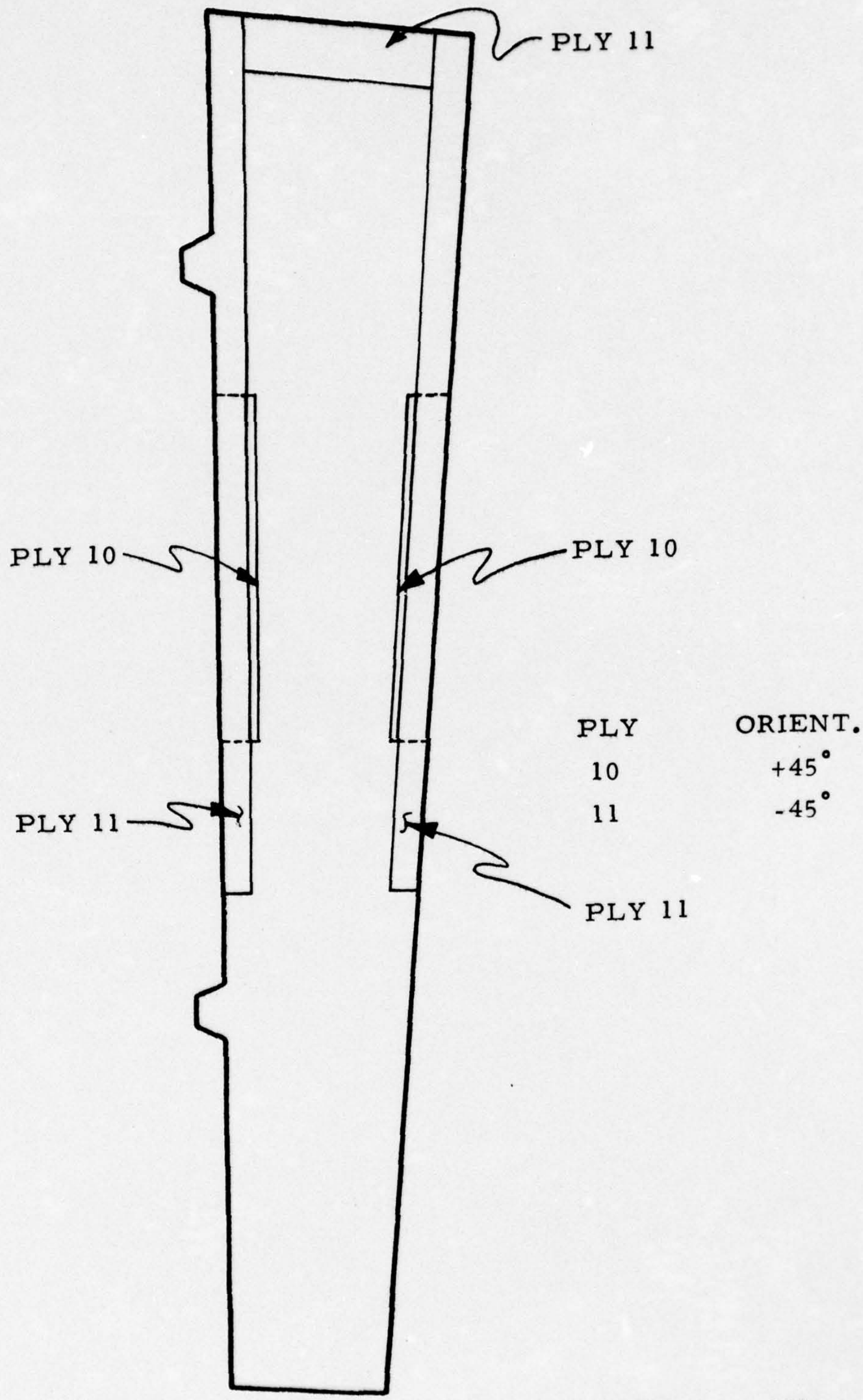
A. Apply film adhesive, specification 207-8-415, type II, grade 10, to -22 and -23 (reference II)

B. Position -22 and -23 on assembly



PLY	ORIENT.
1	0°
2	0°
3	+ 45°
4	0°
5	0°
6	-45°
7	0°
8	0°
9	0°

FIGURE C-1 LOWER SKIN



PLY	ORIENT.
10	+45°
11	-45°

FIGURE C-2 EDGE DOUBLERS (PLIES 10 & 11)

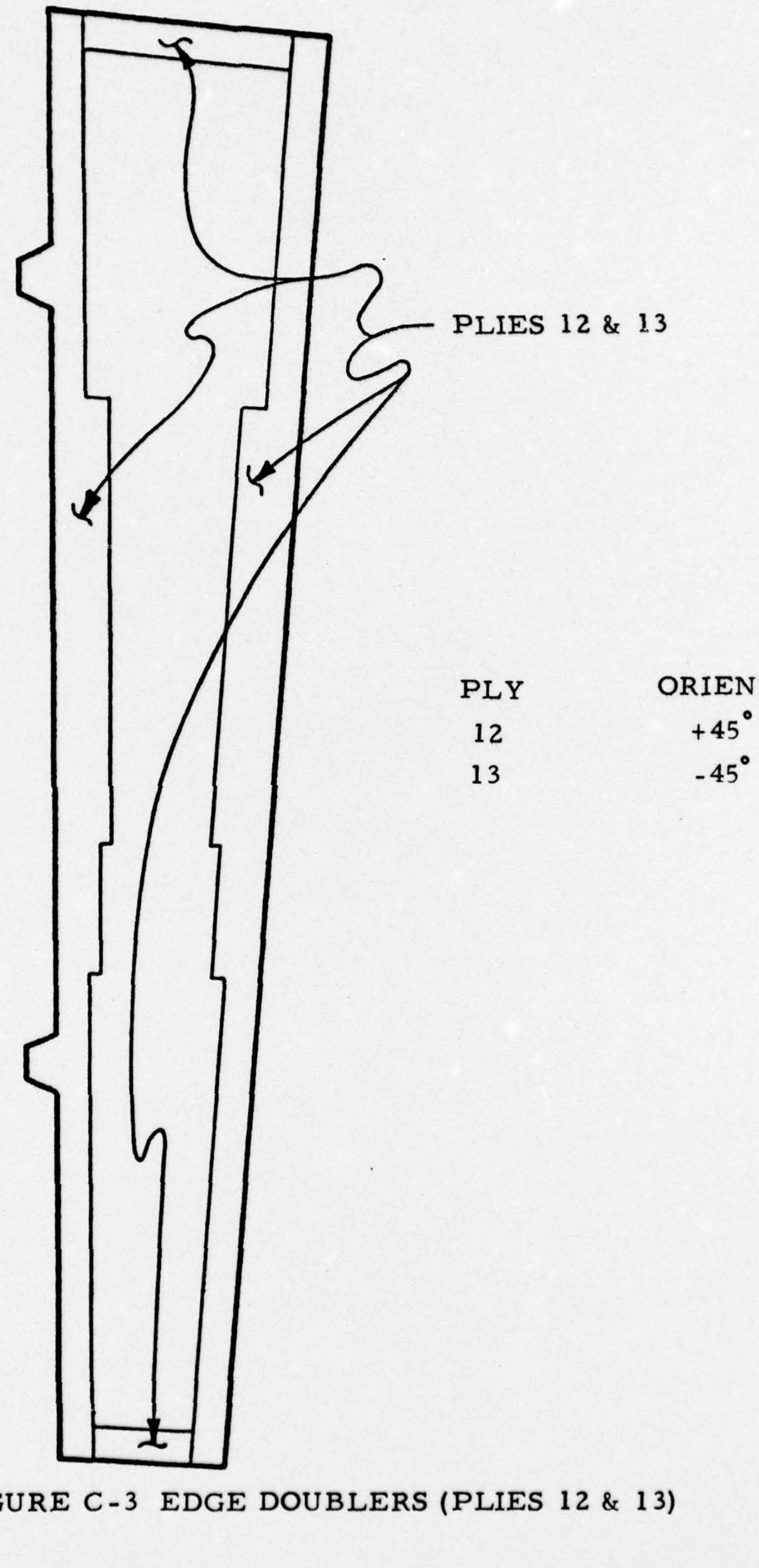


FIGURE C-3 EDGE DOUBLERS (PLIES 12 & 13)

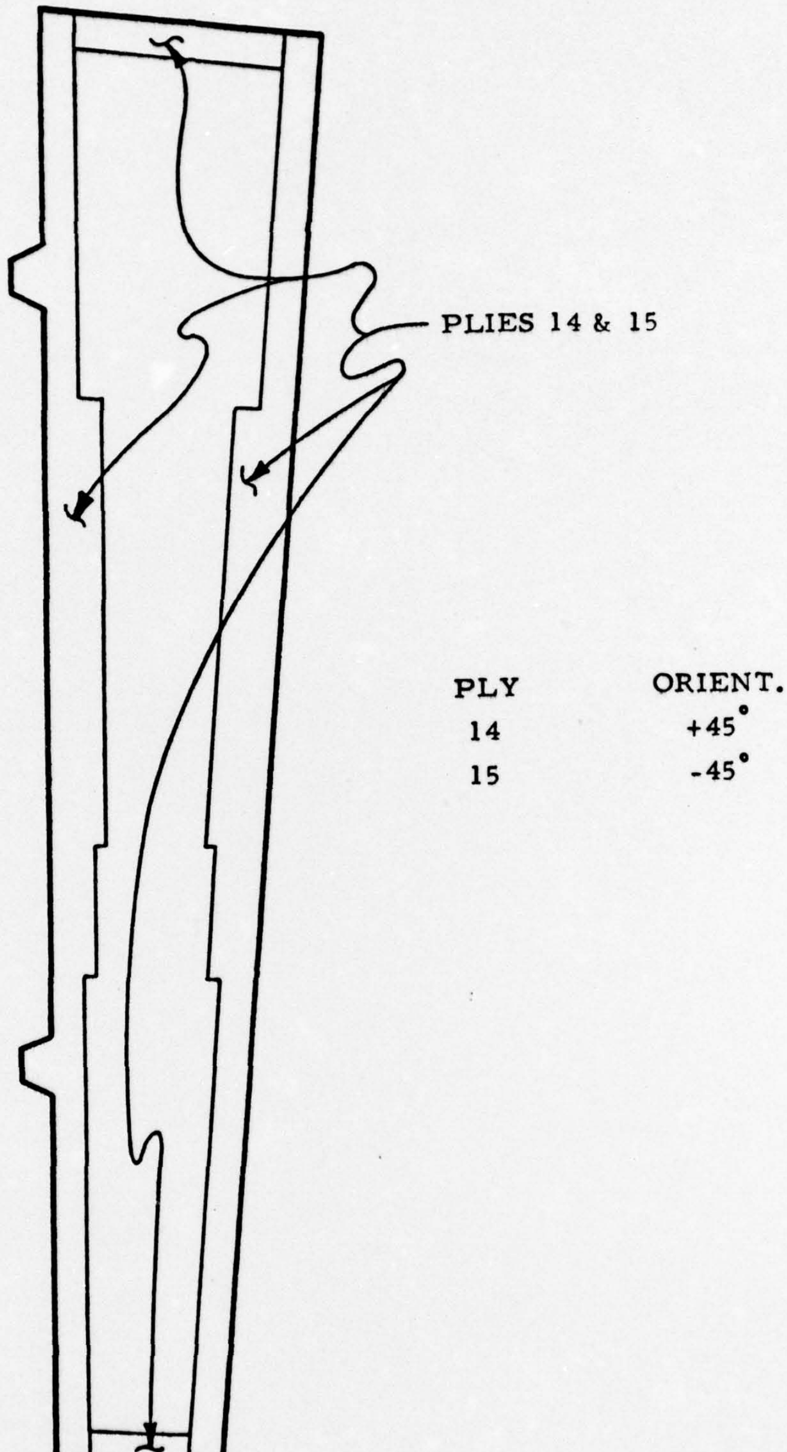
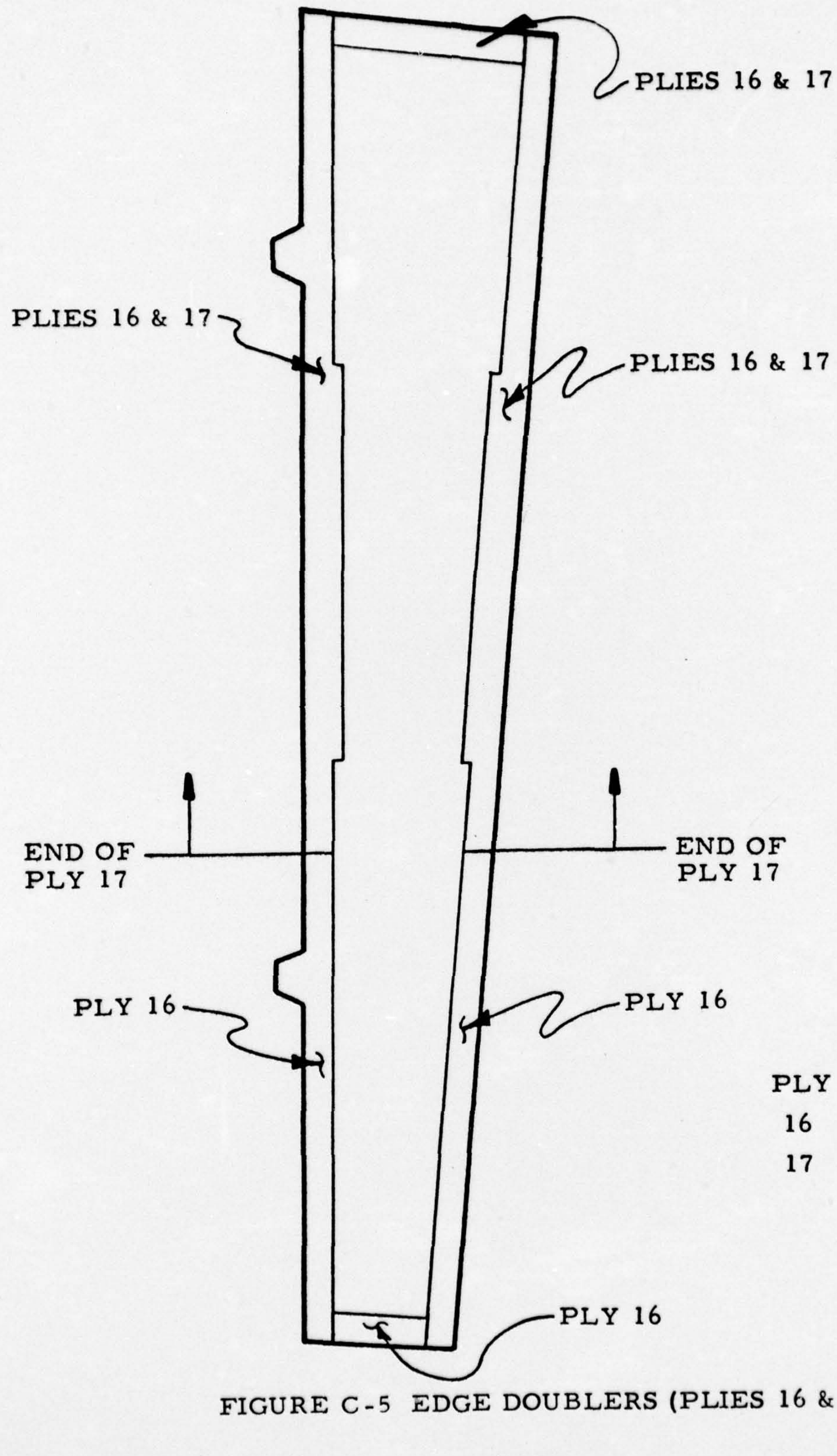


FIGURE C-4 EDGE DOUBLERS (PLIES 14 & 15)



PLY	ORIENT.
16	+45°
17	-45°

FIGURE C-5 EDGE DOUBLERS (PLIES 16 & 17)

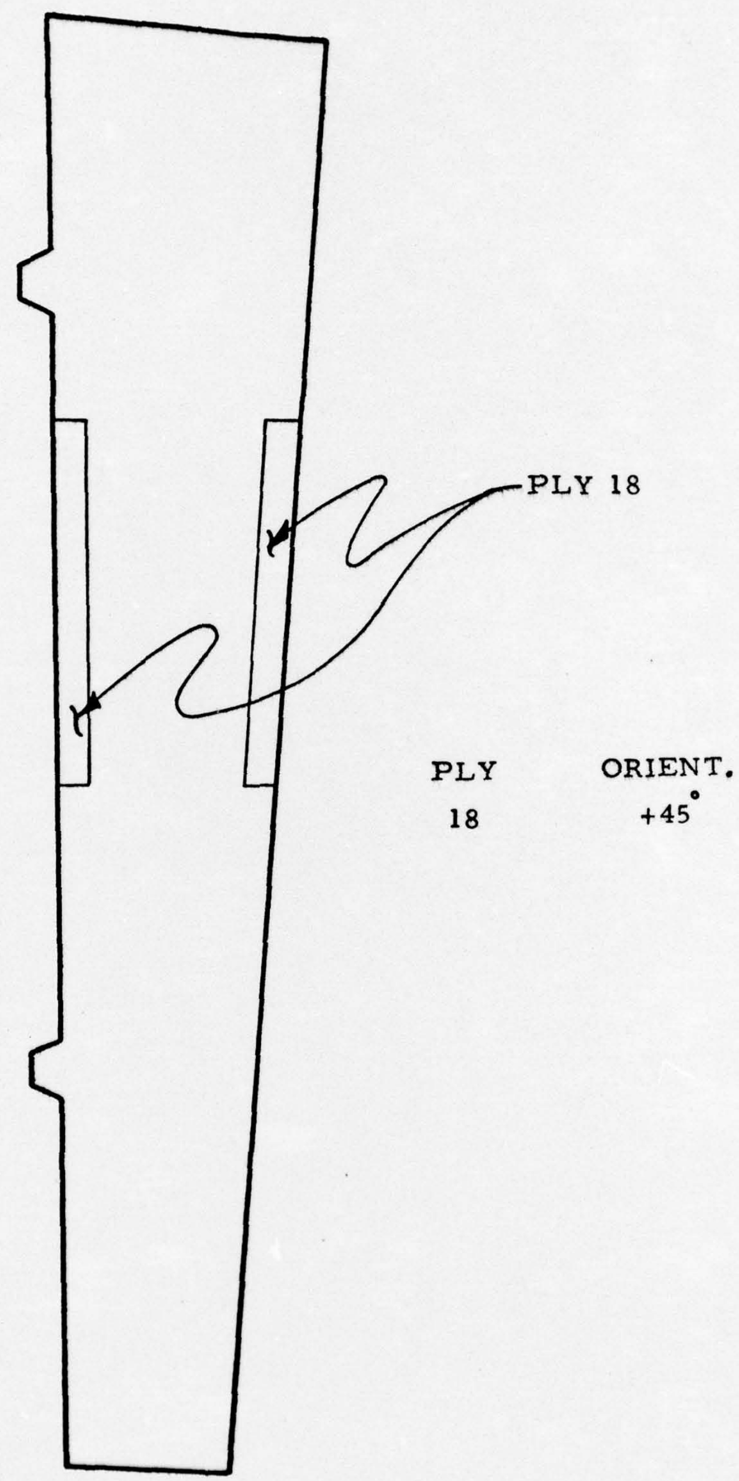
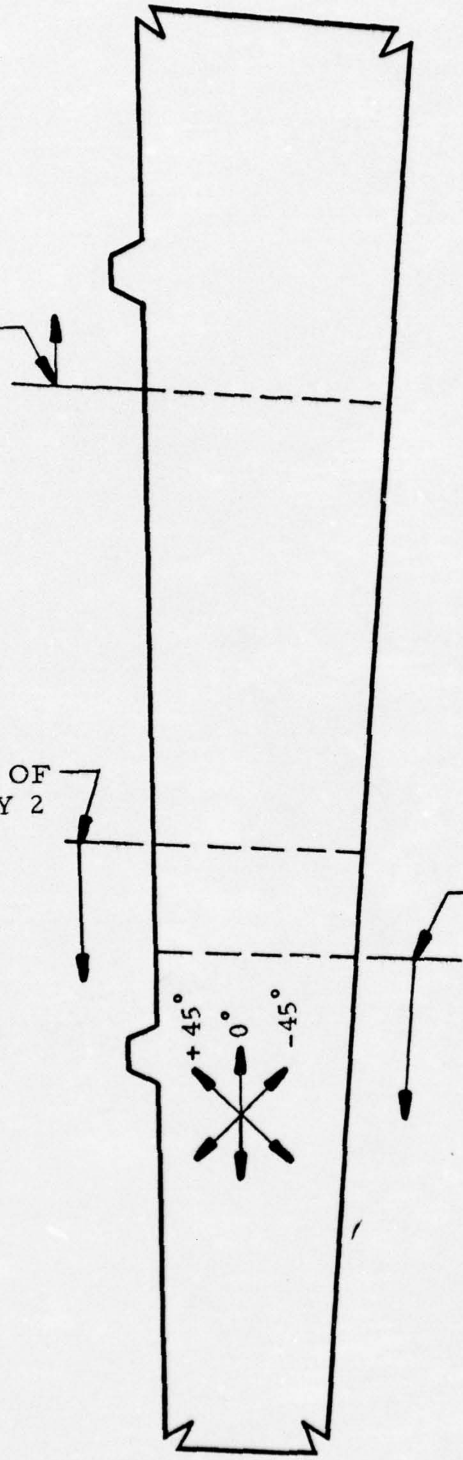
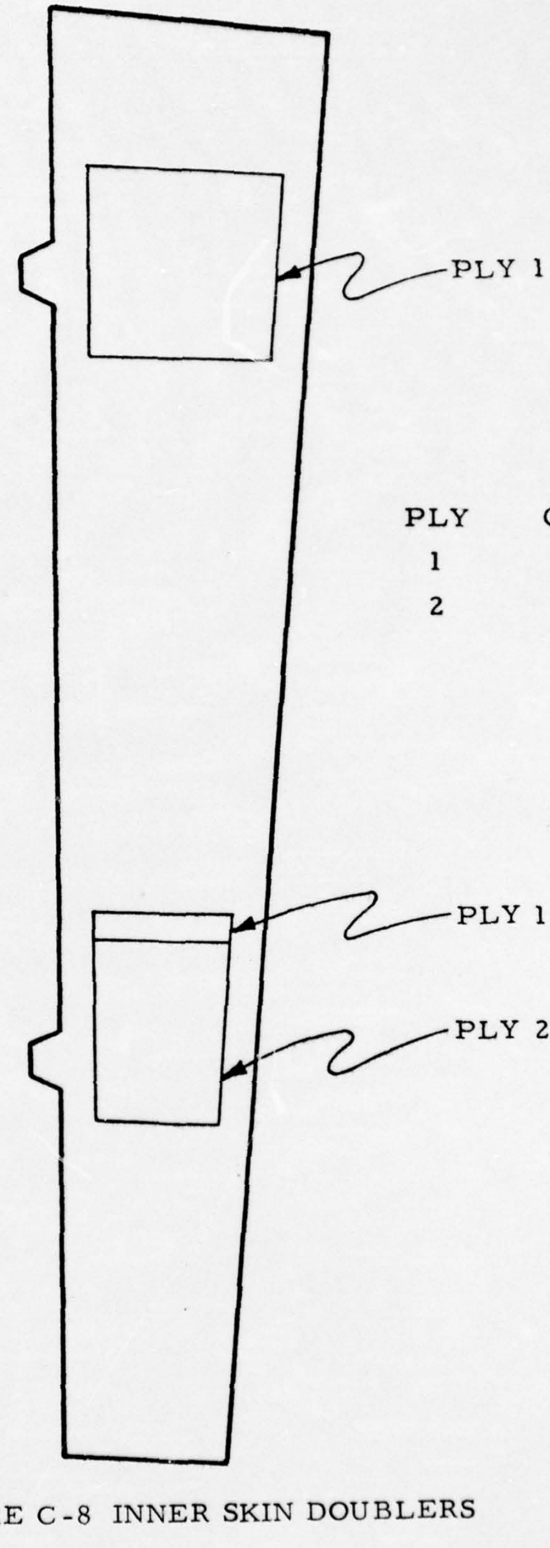


FIGURE C-6 EDGE DOUBLERS (PLY 18)



PLY	ORIENT.
1	0°
2	0°
3	0°
4	-45°
5	0°
6	0°
7	+45°
8	0°
9	0°

FIGURE C-7 UPPER SKIN



PLY	ORIENT.
1	0
2	0

FIGURE C-8 INNER SKIN DOUBLERS

C. Prepare for cure, specification 208-8-3

   1. Similar to item II.C.1 thru 6

D. Autoclave cure

   1. Door close to door open - 4 hrs.

E. Debag

F. Rough trim (remove excess resin and molding flash)

G. NDT (24 - 36 hrs. turn around)

H. Machine to final size (leave tooling tab at each end)

I. Install hinges

   1. Using production hinges and shims

      a. Load hinges and spoiler in assembly tool
      b. Pilot holes in hinges and spoiler (inner skin only)
      c. Drill hinge bolt holes in hinges
      d. Install inserts

         (1) .5 diameter hole in spoiler inner skin
         (2) Under cut core
         (3) Clean core

            (a) Solvent flush
            (b) Dry (160F for 1 hr.)

         (4) Using paste adhesive, specification CVA 8-405, type VI

            (a) Mix adhesive
            (b) Fill cavity (1/2 full)
            (c) Install inserts
            (d) Fill cavity
            (e) Cure (8 hrs. @ R.T.)

      e. Using sealant, specification CVA 6-579, seal

         (1) Seal edges of -22 and -23
         (2) Faying surfaces of hinges and shims

      f. Install and torque hinge attach bolts

J. Install seal

   1. Drill 66 holes per engineering drawing
   2. Attach seal with 100V5D rivets

K. Finish per 78-002553

L. Final Inspect

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S-3A
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Graphite epoxy
cocure
HRP core
Stiffness design
Low cost

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The S-3A spoiler is designed as a cost competitive lightweight replacement for the metal spoiler, and is fit and functionally interchangeable with the existing part. The spoiler is of sandwich construction with graphite/epoxy faces and non-metallic core. The component was assembled by co-curing the wet laminate faces and HRP core.

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Structural analysis and design of the composite spoiler was based on existing criteria and load requirements as specified for production components. Design verification and manufacturing development tests were conducted to predict structural capability and solve manufacturing problems encountered during fabrication. The component is deflection critical and sizing was based on this construction.

Five components were fabricated. The manufacturing development article was cut into element specimens and tested to evaluate manufacturing processes. Three components were static tested, and successfully met design requirements. One component was successfully fatigue tested to two lifetimes without failure.

A cost monitoring system was employed throughout the span of the program and each cost element was identified. A cost matrix and graph comparing the metal and composite components was constructed. Cost data for the composite was extrapolated to 200 units and compared to actual and projected metal cost.

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